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"Facing both ways" an investigation of the mix of situated knowledge and formal knowledge in boat building.

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Declaration

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ABSTRACT

This study looks at vocational curriculum and pedagogy within the context of internal knowledge structures. Focused on a South African boat building qualification, to determine the nature of the qualification and the enacted curriculum with respect to the type of knowledge required in boat building labour processes. In particular the study focuses on the dual demands of innovation and reproduction in a global context. The study attempts to broaden two empirical studies done by Gamble (2004) and Coetzee (2011) into cabinet making and train driving respectively, and an HSRC commissioned study (2015) into artisanal work of the future.

The study develops a conceptual framework of the logic of boat building work that meets the dual demands of innovation and reproduction. The conceptual framework develops the hypothesis that different types of knowledge are required to meet the competing demands of 'innovation' and 'reproduction'.

To explore the hypothesis, a labour process analysis is undertaken and then the structure and content of the qualification is examined using a coding device re-contextualised from a four-way knowledge schema developed by Gamble (2016a,) as well as an examination of the workshop component of the learnership and the learning material.

The study finds that the curriculum attempts to teach in an old craft-based method of apprenticeship. It also finds that the qualification addresses the procedural and sequential requirements of boat building. The problem is that while this addresses the historical craft-based aspects of the trade, it does not support technological innovation.

In conclusion, the contribution of this study is to the importance of knowledge in vocational education and, in particular theoretical scientific knowledge and, the role it plays in vocational qualifications and curriculum in a technologically developing world.

ABBREVIATIONS AND ACRONYMS

CBMT: Competency Based Modular Training

HSRC: Human Sciences Research Council

IMO: International Maritime Organisation

ISO: International Standards Organisation

LMIP: Labour Market Intelligence Partnership

merSETA: Mechanical Engineering and Related Services Sector Education Training Authority

NQF: National Qualifications Framework

RPL: Recognition of Prior Learning

SAQA: South African Qualifications Authority

SGB: Standards Generating Body

SOP: Standard Operating Procedure

TVET: Technical and Vocational Education and Training

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CHAPTER 1: AN INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

This is a study of situated knowledge and principled knowledge in vocational education. The study examines a Competency Based Modular Training (CBMT) qualification and its suitability in meeting employer requirements.

In both professional and vocational education there is a disconnect between what is learned in the classroom and what is learned in the workplace. This is exacerbated in an industry like boat building in South Africa where there have been no formal qualifications, because the preference of employers is for 'on the job' training and this is how employers prioritise the acquisition of knowledge and skill. This results in an inherent bias by employers in vocational enterprises, particularly at the middle and lower level of the market. This study, examines the boat building industry in South Africa where it is possible to be employed without a formal qualification and artisans in the industry have either entered from other trades, or they were passionate about sailing and boating and learned on the job.

There are two points of origin for the study. Firstly, from a practical point, I have worked in the boat building sector for over nine years. Secondly from a theoretical point of origin, my interest in knowledge structures was piqued after encountering the work of Bernstein in my coursework component. Bernstein described the schooling environment and I then discovered a further body of knowledge in vocational education (Coetzee, Gamble, Wheelahan, Wolf and Young) that catalysed my thinking for the framework for a study into the vocational occupation of boat building in South Africa. More background on the origins of the study and its inherent limitations are covered in the Methodology chapter.

In this chapter, to locate the research question, I will give an overview of the industry and discuss the dual demands of innovation and reproduction in a global market context. I will then outline how the boat building qualification was developed in competency-based format.

1.2 OVERVIEW

Vocational qualifications and curricula are usually described in terms of competence or skill, where knowledge tends to be positioned as 'underpinning'or 'embedded'. This results in a disconnect where knowledge is removed from the disciplinary system of meaning in vocational education.

With contemporary conditions of global competitiveness, the study views knowledge as a crucial and integral component to training and aims to investigate what kinds of knowledge are required in the modern boat building industry in South Africa.

The introductory chapter starts with a discussion of the boatbuilding industry in South Africa, to explain why boatbuilding qualifications need to meet a dual demand for innovation in design and production, and high levels of "reproduction" to satisfy the increasing international quality standardisation.

1.3 BOAT BUILDING AS AN ANCIENT TRADE IN A CONTEMPORARY 'HIGH-TECH' INDUSTRY

Mindful of the modern context, it is important to consider the ancient origins of this trade. Greek and Roman mythology tells us of the adventures of Ulysses, the hero of Homer's world-renowned epic The Odyssey. During ten long years Ulysses roamed the seas, driven away from his native land by adverse winds, sailing about from place to place, losing his ships and companions until at last the gods allowed him to return home (Guerber 1907: 301). In the Western world, the earliest evidence of boats is dugouts or canoes from the peat of Pesse in the Netherlands in the Pleistocene era over 8000 years ago (Bednarik 1997:183). The Viking era between the 8^{th} and 10^{th} centuries, saw the Scandinavians dependent on the North Sea and the Baltic Sea for survival, and on their clinker build techniques used to construct Long ships for both merchant needs and warfare. Both the Mediterranean and South East Asia have a long history of ship and boat building and seamanship. Interestingly some of the first boats ever built are still recognisable within the modern context of boat building, despite technological developments and innovations over 8000 years.

With roots in wooden boat building, this ancient trade has evolved over the centuries as different materials and methods of construction have been used. With each boat built "fit for purpose", the requirements for waterborne craft uses have expanded exponentially from its early beginnings. Boats today are used for recreation, rescue, communication, transport, fishing, racing, ambulances and more. Each different application requires an appropriate design and construction methodology.

In South Africa, the modern boat building industry, as a commercial enterprise, only started to emerge in the late 1970s and reached a peak in the 1990s. The industry grew from a strong base of passionate South African sailors who entered the boat building industry out of a love for sailing and boating. Starting as micro enterprises they built their companies over the years with a strong "family business" model underpinning many of the current business concerns. Competing globally with cheaper labour costs, South Africa started to build an international reputation, firstly with custom-built sailing boats and then with the niche specialisation of luxury catamarans, or twin hulled vessels, primarily used for the recreational market. Globally, the South African boat building industry is an emergent one with a relatively short history of production, but South Africa continues to compete globally as the second largest manufacturer of catamarans worldwide, after France.

Boat building is one of the oldest engineering-related occupations. Relying on theoretical imperatives of design, it also has a solid grounding in practical execution. To build a boat there are many stages and processes that must take place. Despite advances in technology, many of the tasks and conditions associated with building, launching and maintaining a boat remain the same as they were thousands of years ago. The shape and complexity of the work involved in assembling and outfitting boats means that the process remains labour intensive, often in physically challenging situations.

Boat manufacturing and design is constantly evolving. Manufacturers need to produce high quality products at affordable prices. They need to maintain safety and regulatory compliance and meet the needs of consumers, both existing and new. Market opportunities are the key driver for development and a boat builder needs to translate those market opportunities into innovative designs to grow and retain market share. This requires "thinking ahead" in order to undertake the tooling ahead of anticipated market demand. Whilst tooling times have been shortened drastically with the use of CNC machining, robotics and precision engineering tools compared to fifty years ago, a boat builder still needs to anticipate the market demand and understand customer differentiation, for example designing and producing boats for Millennials, as opposed to Generation X and Baby Boomers.

Innovation takes place at multiple levels in boat building. Keel, hull and transom designs have evolved substantially over the last fifty years and increasingly one sees sustainable design imperatives in both the "green" operation of a boat, as well as the recycling of boats. The European Boat Cycle Project estimates that there are over six million boats used in Europe annually and that the average life of a boat is between 10 and 30 years depending on design and usage. It has become evident that legislation for management, scrapping and recycling of boats is increasingly important, and critically highlights the need to engage with boat recycling at design phase and not at 'end of life'. Building materials and techniques continually evolve as well as significant advances in propulsion systems. Electronics, GPS, satellite technology, wi fi connectivity, auto pilot, Emergency Positioning Indicator Radar Beacons (EPIRBs) and Auto Identification Systems (AIS) are becoming more efficient and complex and the integration of new products onto a boat requires innovative thinking and strong technical expertise. Creature comforts and aesthetics on a boat also come with a myriad of innovative technologies that require installation, integration and management, such as air conditioners, water makers, electric toilets, sound and video systems and more. Taking aesthetic cues from design evolution in other sectors, such as the auto, aero and clothing sectors, boat building continues to remain on the cutting edge of design at both an engineering and an aesthetic level.

For the South African boat building industry working in a global context, these innovation drivers, as well as the need to reproduce boats to a consistent standard that meets global safety and regulatory compliance, are the primary design and production drivers.

Internationalisation and global competition has resulted in those "consistent standards" being formalised with the development of an international quality control system of the International Standards Organisation (ISO), amongst other standards bodies globally. Boats exported to Europe are built to the ISO standard and this is verified by certification bodies to ensure quality compliance. Other standards exist in other countries and different certification bodies take responsibility for verifying the standard of boat built. The standards are strongly driven by the need for safety and ever improving safety in the boating world. In general, standards are written in a certain way and follow a pre-determined format with a strong technical language employed. In a boat building yard the standards are translated into "well established procedures" that are are usually defined by a "Standard Operating Procedure". This is a document which, together with the drawings, explicates each step of the build processes to minimise risk and to ensure standards are adhered to.

The improved standards have been driven by a concomitant improvement in materials and technologies, and technological developments have resulted in materials changing over the years. For example, boats were traditionally built out of wood but today boat hulls are built from a range of different materials such as fibreglass, aluminium, steel, concrete and composites. Materials and technology development is driven by the need for stronger, lighter and faster boats which results in improved performance and fuel efficiencies.

In addition to this, the growth around environmental concerns globally means there is an increased focus on "green" technologies and alternate propulsion methods. For example, in more recent years one has seen the introduction of solar technologies on boats, electric engines and other hybrid propulsion systems. The drive for a cleaner more environmentally friendly world will not exclude the boating world and already Nitrogen Oxide Emission NoX Tier III regulations are enforced by the International Maritime Organisation (IMO) for the superyacht sector. With Britain, France, the Netherlands and

Scotland having set target dates for a ban on petrol and diesel cars last year, and with China considering the same, it is likely the boating industry may also fall under future legislations that try to align emission regulations worldwide.

Materials development and technological advances do not take place in a vacuum and in building a boat there is a constant iterative relationship between design, materials and manufacturing processes. This iterative process becomes increasingly complex during the building process and there are a myriad of different combinations at play at different stages when building a boat. The different manifestations of the design, materials and manufacturing process results in boat building yards differing even though they are all producing the same product, a boat. This is reinforced by the findings of Glass and Hayward in a New Zealand study into boat building which found that "innovations arose from the creative application of technologies – making them fit the specific context – rather than acquiring them in ready form" (2001:586), illustrating an iterative dynamic between technological development and context.

If one then considers the vocational training required in a boat building yard, considering these processes, it becomes clear that there is very strong context specificity in boat building. To be innovative and to produce work that consistently meets the same high international manufacturing standards, the question arises as to what knowledge boat builders need within this context specific environment.

1.4 BECOMING A BOAT BUILDER

As in other countries with deep roots in traditional craft (Deissinger, 2001), the boat building industry in South Africa has favoured workshop-based training practices and on-job training as ways of building expertise. Despite industry growth between the 1970s and 2000s no formal boat building qualification was available. At the top level, boat building "borrowed" from other training such as architecture, drafting, joinery and engineering and at the lower level people were trained on the job to meet production demand.

In 2005, as the boat building industry in South Africa started to formalise in response to a need to remain globally competitive, an industry export council was formed, and the members identified the need for a formal qualification. Ten years earlier, with the transition to a democratically elected government in South Africa, there were efforts to emphasize the centrality of training to the reconstruction of South Africa and to propose an integrated approach to education and training (National Training Strategy Initiative 1994: 1). Principles of integration, relevance, access, progression and articulation, amongst others, underpinned developments in the education and training space and the subsequent development of the South African Qualifications Authority, the adoption of the National Qualifications Framework (NQF) and an outcomes-based Competency Based Modular Training (CBMT) approach. It is therefore not surprising, that the boat building industry, in the early 2000s also started to look at formal competence-based qualifications. For the boat building industry, the expectation of a clearer link between training and work and the economic driver to be globally competitive, to meet improved safety standards, to advance technological developments and to meet increased environmental considerations provided a consistent logic to creating a formal qualification and the developments were welcomed by the industry.

There were high hopes for the NQF in South Africa and the closer link between training and boat building labour processes boded well for the introduction of the formal qualification that would also allow for Recognition of Prior Learning (RPL) for those historically trained on the job. It was intended that the NQF would ensure high quality training that also supported learners who had historically been denied access to education and training (Allais, 2018: 119).

Key people in the boat building industry were involved in the development of the qualification which was co-ordinated by the Mechanical Engineering and Related Services Sector Education Training Authority (merSETA), responsible for quality assuring the qualification. A Standards Generating Body (SGB) was convened and the boat building industry, organised labour, and subject matter experts were invited to participate in the qualification development, under the guidance of an education expert convenor. Under the National Skills Development Strategy (1998) stakeholders and employers were expected to define the learning outcomes to ensure that training would be responsive to employers' needs (Allais 2018: 119).

The "Small Craft Construction" learnership was developed at NQF Levels 2 – 4 in 2006 under the auspices of the Mechanical Engineering and Related Services Sector Education Training Authority (merSETA).

The mandatory requirement that Fundamental unit standards be included in the qualification was resisted by industry. Industry felt this type of content should have already been addressed in the school curriculum and that it was not the role of a boat building qualification to teach pure maths and literacy competence when it could be taught in an applied manner within the Core unit standards (Boat Building Qualification Review, Draft Process Report, no date). Already at the outset, this debate at the SGB level highlights the tensions between theoretical and practical knowledge; between principle and procedure, between educational constructs and the world of work.

Another important consideration was the adoption of what is termed a "learnership" qualification. Like many other countries, South Africa reinvented the concept of apprenticeship during the mid-1990s and The Skills Development Act (No. 97 of 1998) replaced apprenticeships with learnerships, where a work integrated learning programme in the vocational arena became known as a learnership (Smith, Jennings and Solanki 2005:538). This legislative stipulation required that learners spend 50% of their time in a formal college learning environment, followed by 50% of time in the workplace applying the skills they had acquired. In principle this approach was embraced by the industry who viewed it as a version of the old apprenticeship system, which was perceived to be successful due to the master/apprentice relationship whilst completing the work integrated learning component. However, the use of unit standards as the basis of learnerships, is indicative of a change in the theory and practice traditions of the commonly understood apprenticeship system, where either scientific knowledge was added to on-the-job work or when theory and practice, as held by the master, was passed on to the apprentice. In summary, disjuncture in thinking and perceived (mis)understandings of the nature of how one learns to become a boat builder, underpinned by policy determinations, muddied the waters of this qualification development.

Despite this, the general consensus was positive, and it was anticipated that the qualification would address the industry skills deficit from training 'on the job'. However, when the qualification was implemented by the Technical Vocational Education and Training (TVET) College many boat builders reported that learners on the work placement component of the course did not have the required skills and attitude needed, despite the formal training. A study into the Boat Building Sector in the Western Cape by the Co-operation Framework on Innovation Systems between Finland and South Africa (COFISA) and commissioned by the Western Cape Provincial Executive (2009) found the following:

> "In 2006 the CTBI, in co-operation with False Bay College, established the *"Cape Town Boat Building Academy"*. This institution offers a practical 3 year (full time) course teaching general boat building skills and culminating in a SAQA accredited *"Certificate in Small Craft Production – NQF Level 4"* While the idea behind this initiative is to be applauded its

> implementation appears somewhat vague and its qualification lacks specialisation. It has been argued that the course curriculum does not provide its graduates with any clearly identifiable trade, and even after qualifying successfully they fall well below artisan standard and are unlikely to be able to make a useful contribution in the workplace."

This was viewed as a significant obstacle to progress for the industry who felt that the qualification lacked specialisation and produced artisans without a clear-cut trade and poor work standards. The qualification was therefore revised three years later, again with industry involvement and with the intention of "fixing" the problems. I participated on the second SGB along with two other senior industry experts, one a boat builder with international experience and the other a naval architect. The qualification was renamed a "Yacht and Boat Building" learnership at the same NQF levels. This second iteration of the qualification was strongly aligned to international best practice, with a focus on the Nova Scotia Boat Builder Certificate, due to the then TVET College Boat Building Academy Manager having trained in this system. In both instances, the qualification remained firmly entrenched in the format prescribed by the South African Qualifications Authority (SAQA), and it followed the prescribed qualification format including unit standards, learning outcomes, assessment criteria, range statements and a particular language of description.

Within the CBMT logic, a learnership must be outcomes focused with everything framed in measurable statements or learning outcomes. This creates a conundrum, in that it allows little space for formal knowledge specifications and critically it does not acknowledge tacit knowledge which is an inherent component of an historical trade such as boat building. In knowledge terms this is particularly challenging, as boat building is both an historic trade and a modern trade where a workshop-based apprenticeship favours situated knowledge and knowledge acquisition through production. At the same time, the industry operates in a global market with strong technological developments and international quality assurance systems. All these mean that the industry need formal scientific knowledge to remain competitive and current.

1.5 RESEARCH FOCUS

It is perhaps therefore understandable why the boat building industry remains concerned about what the qualification achieves and questions if the qualification does indeed build a sufficient base of expertise. It is this core concern that led me to take up the topic as a research focus area. If the sector favours knowledge acquired through production or situated context specific knowledge, but is also driven by technological advances, improved safety aspects and "green" developments, then why is the South African qualification of concern to the industry, particularly because the industry was integrally involved in the development of the qualification and its review? More specifically, I want to investigate the concomitant industry drivers for innovation and reproduction and to explore whether a vocational qualification can adequately meet this demand for a trade that locates itself both within an historical and a modern context. Therefore, my primary research question is:

"To what extent does the South African Boat Building qualification meet the dual demands of both innovation and reproduction by industry?"

The sub questions that arise from the primary question are:

What combinations of knowledge are required in boat building practices?

What knowledge is contained in the boat building qualification?

What is the relationship between knowledge and different types of labour processes in boat building?

The study aims to contribute to the understanding of the kind of knowledge and qualifications needed in vocational work, with reference to the boat building sector. The thesis builds on the study done by Coetzee (2011) into the work of risk in train driving in South Africa and Gamble's study into craft-based training in the cabinet making sector (2004).

1.6 ORGANISATION OF THE STUDY

Chapter 1 has outlined the purpose and rationale of the study.

Chapter 2, 'Literature Review' locates the study within the debates about the nature of vocational knowledge. Firstly, looking at the tension between formal and situated knowledge, the review looks at the work of Bernstein and his notions of horizontal and vertical discourse. I then look at Gamble's (2004) study into craft knowledge. The review then goes on to look at competence as a basis for the vocational education and training curriculum and various critiques. The work of Wolf (1995) provides a baseline and I then review the critiques of Young, Allais and Wheelahan in the vocational education arena. The empirical studies of Coetzee (2011) and Gamble (2004) are reviewed and lastly, I review the literature on knowledge, innovation and reproduction, looking at the work of Kumar, Brown, Lauder and Ashton and Muller. The chapter concludes with a conceptual knowledge framework adapted from Gamble and a framework drawn from work itself, showing the relation between production and knowledge.

Chapter 3, 'Methodology' describes the case study approach used and diagrammatic illustration of the thesis logic. The data collection sources are specified as well as an explanation of the knowledge coding devices and analytical markers used.

Chapter 4, 'The logic of boat building work', exemplifies semi-skilled and skilled labour processes in the boat building industry with respect to company size.

Chapter 5, 'What knowledge is found in the unit standard qualification?' examines the 'National Certificate: Yacht and Boat Building' according to assessment criteria and an analysis of the knowledge types.

Chapter 6, 'The Enacted Curriculum', presents empirical data and analyses of the TVET college workshop activities and learning material.

Chapter 7, 'Discussion and Findings' is the concluding chapter and presents the overall findings of the study, pulling together the findings of the labour process analysis and the curriculum analysis.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, two core areas of literature are reviewed. Firstly, locating the study in the educational arena, I look at debates on the nature of vocational knowledge, in particular the tension between formal and situated knowledge and its theorisation by Basil Bernstein and other theorists following in the Bernsteinian tradition. This is extended to look at competence as a basis for vocational education and training curricula, and a close review of two empirical vocational studies undertaken by Gamble (2004) and Coetzee (2011).

Secondly, I review the debates of knowledge, innovation and reproduction and look at the distinctions between flexible specialisation and routinisation by labour process theorists, as well as Muller's (2000) distinction between social practice driven innovation and knowledge driven innovation.

I conclude the chapter with two conceptual frameworks, one drawn from work itself, and the other drawn from knowledge types in the vocational curriculum informed by Gamble's four-way knowledge construct (2016a).

2.2 DEBATES ON THE NATURE OF VOCATIONAL KNOWLEDGE

2.2.1 Vocational knowledge as a tension between situated and formal knowledge

The distinction between situated knowledge that is learned experientially through doing and disciplinary 'school' knowledge, is well established in the literature on school knowledge. It is Basil Bernstein's distinction between what Durkheim calls the 'profane' world and the 'sacred' world that raises the categories of situated and formal knowledge to a conceptual level where they can be accessed by educational domains other than academic schooling.

Bernstein determined a structural distinction between theoretical knowledge, or knowledge with specialized meaning, accessible only by those who have mastered the principles of its symbolic organization and everyday knowledge created through experience. In ordinary terms, this is a distinction between 'commonsense' knowledge of the everyday world and the 'uncommonsense' knowledge taught in the school curriculum. In later work, Bernstein refers to a distinction between horizontal and vertical discourse (Bernstein 1996, 1999, 2000).

It is this latter distinction which has been taken up in the vocational domain by several theorists working within a Bernsteinian tradition. Young interrogates the academic vocational divide in schooling in England and the issue of "how vocational knowledge can be distinguished from school or academic knowledge on the one hand and from skills and knowledge that can be acquired in the course of work, on the other" (2008: 143). He identifies "the problems of progression faced by students who follow vocational qualifications which neglect subjects and are based on the assessment of processes not content" (1998: 62). Young argues, that in contrast to school curriculum debates, debates about what knowledge vocational programmes should include has had less focus (2008: 138).

Wheelahan, also working within the Bernstein tradition, investigates the effect of competence-based 'training packages' on VET in Australia. Wheelahan's studies on CBMT found that working class children are disadvantaged by CBMT methodologies as they are denied access to, what Young terms, ‘powerful knowledge”. Using Bernstein’s discourse, Wheelehan identifies that CBMT *delocates* knowledge from the vertical discourse and *relocates* it closer towards horizontal discourse. This “changes the nature of knowledge, and the processes through which it is acquired.” (2007: 648).

Barnett refers to Bernstein’s explanation of the recontextualising logic of curriculum to show how a vocational curriculum comes into being. According to Barnett situated knowledge is closely associated with particular tasks and “is essential for getting anything done but may have no significance outside very particular contexts”, whereas disciplinary knowledge rises above the particular to a level of general applicability (2006: 146). Generally, the higher one progresses in a workplace the greater the emphasis on formal or disciplinary knowledge required and at the lower ends of the workplace the greater likelihood of strongly situated knowledge processes.

> “Situated knowledge often does not readily mix with, or easily relate to, disciplinary knowledge. It is often trapped within its context of application, while disciplinary knowledge generally aspires to some degree of context-independence, to rising above particularities, to some measure of general applicability. Situated knowledge is frequently tacit and difficult to put into words, sometimes even tacit in terms of how it feels to do a job correctly and therefore it is hard to codify” (Barnett, 2006: 146).

Gamble’s (2004) work focuses particularly on craft knowledge. Drawing on Bernstein’s original distinction between hierarchical and horizontal knowledge structures in vertical discourse, and his categorisation of craft as a tact horizontal knowledge structure, Gamble undertakes an empirical study of the craft of cabinetmaking. To set up a conceptual framework for exploring craft as a knowledge type, particularly the tacit nature of craft knowledge, Gamble turns to the work of Pye (1968) and Polanyi (1958). She shows how craft apprentices can ‘recognise’ and ‘realise’, in Bernstein’s specialised language, a formal part-whole principle of order, encoded in the design of a piece of furniture, without necessarily being able to describe the principle in words. This is referred to as ‘craft knowledge’.

It is this complex understanding of craft as a tacit/restricted form of principled knowledge that leads Gamble (2006) to theorise the relationship between situated and formal knowledge in the vocational curriculum as more than a distinction between ‘theory’ and ‘practice’. In later work, she argues that it is the logic of work itself which tells us what kind of knowledge is built into different types of work organisation. Where the end result of work is predetermined or certain, risk is low and work routines are based on sequential procedural knowledge. Where the end result of work is uncertain, because of risk or novelty, the relation between ‘parts and whole’ is a non-linear relation which is either visualised in a drawing (as in craft) or written down in symbols and words (as in formal mathematical and scientific knowledge) (Gamble, 2016a). Using Bernstein’s concept of curriculum ‘recontextualising’ (2000: 113) Gamble argues that ‘the logic of work provides the “recontextualising principle” for the TVET curriculum (2016a: 215). In diagrammatic form, the relationship between situated and formal knowledge that results from this theorisation is depicted as follows:

	SITUATED KNOWLEDGE	FORMAL KNOWLEDGE
PROCEDURAL WORK LOGIC (Certainty of end-result)	**'How to' knowledge** Work procedures or routines learned through everyday experience (not written down) **K1**	**Systems knowledge** Formally codified knowledge of work rules and procedures (written down) **K2**
PRINCIPLED WORK LOGIC (Uncertainty of end-result)	**Craft Knowledge** Principles visualised through drawings and sketches. **K3**	**Scientific knowledge** Principles understood in abstract or symbolic terms **K4**

Fig 1: Types of knowledge in the vocational curriculum (Gamble, 2016a)

What is significant about this curriculum model is that it argues that work with a certainty of end result is grounded in both a situated and formal knowledge component. Work routines with certainty of end result require care and dexterity; but the need for autonomous problem-solving and judgement has been taken out of the work because the solution has been worked out before and workers know what the end result should be. Similarly, work with uncertainty of the end result is grounded in both a situated and formal knowledge component, but here different forms of principled knowledge serve to provide the basis for visualising or reasoning about a solution before it is attempted in practice. There is risk involved as the end result may be spoiled, or it may not work. The second form of work is particularly prevalent in 'flexible' production where design specifications and materials change as the market demands.

2.2.2 Competence as a basis for the VET curriculum

Wolf (1995: 1) defines competence-based assessment;

> "as a form of assessment that is derived from the specification of a set of outcomes; that so clearly states both the outcomes – general and specific – that assessors, students and interested third parties can all make reasonably objective judgments with respect to student achievement or nonachievement of these outcomes; and that certifies student progress on the basis of demonstrated achievement of these outcomes. Assessments are not tied to time served in formal educational settings."

Wolf goes on to further define competence-based assessment by three defining features; firstly, the emphasis on multiple but distinct outcomes, secondly that the outcomes are specified enough as to appear 'transparent' and equally intelligible by everyone and thirdly that assessment is not linked to institutions or programmes and stands alone (1995: 2).

This independent notion of outcomes and assessment criteria that can 'float freely' has become an underpinning concept in the development of National Qualification Frameworks, in the domain of vocational education. The NQF has its roots in a competence-based approach to vocational education and it is important to contextualise NQF developments within the neo-liberal economic policies of the 1980s and 1990s in the United Kingdom (Young, 2005: 5, Keevy et al 2014: 19). This approach emphasised the role of the private sector in economic development and the development of vocational curricula, where it was assumed that employers would be able to specify their training needs. This led, in many instances to the development of employer led standards bodies in specifying curriculum content, outcomes and assessment criteria.

As Allais discusses in her analysis of National Qualification Framework's globally "the intention in many of the countries is that once industry is involved in developing qualifications, the standards or outcomes will be more appropriate, more learners will get better jobs and industry will get the skills that they require" (2011: 15). Wolf, also talking about the emergence of competence-based assessment in the UK, refers to exactly this type of process:

> In practice of course, this tends to mean that there is a small group of enthusiastic industry representatives, more or less self-selected, who meet at regular intervals very much like a company's board, but with the backing of a secretariat of some sort. The actual process of developing standards is generally carried out by consultants (funded by the Government) with the lead body providing general oversight. (1995: 15)

The economic imperative underlying the NQF, and its quest to improve the quality of vocational training, was also linked to the need for companies to compete on a global level. According to Keevy et al (2014: 21) other rationales included social and developmental needs in education and training.

In exploring the transformation of competence in the context of qualification frameworks, Allais, Raffe and Young (2009: 2 -3) explore how outcomes-based frameworks are used as drivers of reform for governments. Allais identifies how outcomes and competency statements "have come to prominence as a policy tool". As such, the outcomes are seen as a way of driving change by virtue of becoming performance statements in educational contracts whereby the qualification is less tied to the training institution and thus become more "portable" and allows for the accreditation of informal and on-the-job learning. (2009: 7).

The United Kingdom government saw competence based awards resulting in qualifications that reflected workplace roles and would "uncouple the acquisition and certification of skills from time-serving either at work or in the classroom (Wolf, 1995: 34).

The codification of competence into a qualification is a complex arrangement and to further understand the complexity, the literature review now turns to critiques of competence as a basis for curriculum.

Wolf critiques the competence-based focus with respect to the tight formulaic way of writing unit standards, learning outcomes, specific outcomes, assessment criteria and critical cross field outcomes which underpin competency statements. Wolf (1995: 19) goes further to say that standards are not an element of qualification, but that they *are* (emphasis in original) the qualification. The performance-based criteria system works within a domain specification (Wolf 1995: 54) which is attractive in that it can address job specifications, but what happens is, that the attempts at rigorous specification, narrow the domain and a "never ending spiral of specification" develops (Wolf, 1995: 55).

Young in his earlier work (2005) identifies a growing body of research suggesting that vocational education reforms based on outcomes is not working out as hoped. In 2008, Young concludes that standards-based approaches in vocational education do not recognise the differences between theoretical and everyday knowledge. He summarises, "As a result, vocational programmes that rely on the standards-based approach deny learners access to the rules governing the production of knowledge by the scientific and professional communities" (2008: 150). Of relevance to this study, Young in discussing the implications for the vocational curriculum says;

> The vocational curriculum always has (or should have) two purposes: providing access to the disciplinary knowledge that is transforming work and acquiring job specific skills and knowledge. The former purpose relies on context independent knowledge whereas the latter will be context-specific and related to specific sectors and workplaces. It follows that there are specific curriculum and pedagogic issues that need to be addressed in relation to the vocational curriculum" (2008: 170).

Allais et al challenge what they term a 'false assumption' in outcomes-based qualifications that "outcomes are the type of knowledge that disclose meaning within and across disciplinary boundaries" (2004: 56). In seeking to get accreditation for a short course in South Africa, Shalem, Allais and Steinberg (2004) encountered a *gap* (emphasis in the original) between what they identified as two different discourses: "the discourse of discipline knowledge, and the discourse of the specification of outcomes". They highlight the "design down logic" of CBMT and learning outcomes, that laudably aims for clear and transparent criteria, whilst in practice learning outcomes subjugate content knowledge selection, sequencing, learning activities, pedagogy and contextualisation. This generic approach implicit in outcomes approaches, they argue, is "based on an assumption that there is no significant difference between disciplinary, occupational and everyday knowledge; it highlights 'skills' and 'competencies' that can be gained through or without immersion in specialised fields of disciplinary content' (Shalem, Allais and Steinberg 2004: 71). In a later work, Allais argues that the issue of knowledge in curriculum development and the power of different bodies of knowledge are embedded in social systems and that "knowledge of the powerful must be seen as conceptually distinct from powerful knowledge, but it is important to explore the ways in which powerful knowledge is entangled with the powerful and with power relations" (2018: 239 – 230).

Wheelahan, also looks at how competency-based training locks the working class out of powerful knowledge (2007). In a recent paper on theorising the conditions for theoretical knowledge in vocational education, Wheelahan, says that whilst efforts have been made to improve vocational training, the underlying problem of excluding student access to theoretical systems of meaning in academic and applied academic domains. This she argues "reduces theoretical knowledge to procedural knowledge; students are told that in order to do x (a practice), they must use Y (a theoretical concept)" (2018: 237). Without access to a system of meaning, Wheelahan says that students, only given contextually specific knowledge, cannot use knowledge in new and innovative ways and thus vocational education graduates remain 'supervised workers' (2018: 238).

2.2.3 Empirical studies on the nature of vocational curriculum

Apprenticeship ostensibly starts with craft and historically it has a knowledge base that has been difficult to describe..

Gamble (2004) found in her study of cabinetmaking apprentices, discussed earlier in the literature review, that a craft pedagogy does in fact transmit knowledge. In this specific study the cabinetmaking curriculum was officially framed in CBMT terms, but in fact, this was not how the master artisan taught. Gamble's examination of the trade test showed that the apprenticeship test requires more than an outcomes-based assessment, it requires an "understanding of the relationship between parts and whole, as well as wholes and parts" (2004: 199). It is this relationship between parts and wholes in pedagogic transmission that makes modelling the only possible transmission-acquisition practice (2004: 141) and apprentices always work on a project or set piece.

In a later paper, Gamble summarises; "No procedure or technique is ever practised in isolation. The part-whole relationship is always in the foreground in the sense that every new procedure is practiced through the construction of a whole item and without direct instructions from the master-trainer" (2014: 64). Of direct relevance to this study is that "transmission practices establish a principle of directionality that transmits a relational or connective work logic rather than a sequential or step-by-step procedural logic: (2014: 64).

As Gamble found in her study, an outcomes-based unit standard qualification "has no place for the specification of a formal knowledge component (other than stating that such knowledge should be in place)" (2014: 15). In addition, the "unspecified role that the 'tacit' has played in the apprenticeship curriculum has thus finally disappeared and been replaced by an assumption that all knowledge can be made explicit and stated in terms that are observable and measurable" (2014: 15). In other words, Gamble shows that the curriculum framework focused on explicit assessment evidence cannot deal with judgement based on tacit knowledge and it therefore excludes craft knowledge in favour of procedural sequential measurable assessment criteria.

In another vocational study, Coetzee (2011) examined the skilled occupation of train driving in South Africa and increased the generalisability of Gamble's craft model, by finding evidence of externally visible performance embedded in an internally held competence (visualising the whole) in train driver's ability to handle risk. Coetzee (2011) found that "not all skilled work can be based solely on the tacit visualisation of principled knowledge in craft" and that "there is a requirement for conceptual knowledge that goes beyond craft." (2011: 76). Coetzee found that this conceptual knowledge requirement that goes beyond craft and cannot be transmitted by a CBMT training logic that is over proceduralised and undermines the basis of skilled performance in train driving. Coetzee found that a competence based modular qualification excludes science-based understanding of things like wind speed, velocity and momentum, which are important to train drivers in the 'risk' component of their jobs. In operationalising her study, Coetzee draws on Gamble's (2004) discussion of Pye (1968), when she sets up the distinction between risk and certainty as the two main conceptual variables of her study. I will be drawing on these same sources used by Gamble (2001) and Coetzee (2011) to set up a conceptual framework for my study on boat building.

The literature review on competence in vocational education, shows that where knowledge is accommodated in outcomes and competence based format and located within National Qualification Framework structures, that it privileges a procedural type of knowledge that is sequential, measurable and closely linked to assessment criteria, that in turn are closely linked to the wording of learning outcomes, specific outcomes, range statements and critical cross field outcomes, as outlined by Wolf in the opening paragraphs of this chapter.

2.3 DEBATES ON KNOWLEDGE, INNOVATION AND REPRODUCTION

While educationalists talk about knowledge in terms of situated and formal knowledge in the curriculum and distinguish between different types of problem solving (Clarke & Winch, 2004; Gamble 2016a) theorists of work and labour process discuss the production process in different terms, notably through drawing a distinction between work as 'flexible specialisation' and an increasingly pervasive shift towards 'routinisation' and proceduralisation of work.

As this additional vocabulary is useful to this study, I briefly introduce some of the specialist vocabulary that deals with the relationships between knowledge, innovation and reproduction (also termed routinisation).

In *flexible specialisation* "production is customised, geared to highly specific wants and needs in a constant state of flux" (Kumar, 1995: 44). Kumar also goes on to say that this novel pattern of production needs "skill and flexibility in the worker as much as in the machine" (1995: 44). In this production pattern, there is continuous improvement and innovation and greater involvement and work satisfaction for the majority of workers where there is a premium on craft skills, whilst also depending on team work across all grades of workers (Kumar, 1995: 47).

Discussion of an oppositional trend is found in the work of Brown, Lauder and Ashton and particularly in their study into new forms of standardised work (referred to as Digital Taylorism).

> "While the policy spotlight has focused on the creation of new ideas, products and services, the ability of companies to leverage new technologies to globally align and coordinate business activities has also brought to the fore a different agenda involving the standardisation of functions and jobs." (Brown, Lauder and Ashton, 2008: 138)

Brown et al also go on to say that standardisation is well understood in manufacturing, where components can be built in separate locations and assembled at a central location "in the knowledge that all the components meet international quality standards and will fit together" (2008: 138). The same logic is now being applied to service-sector occupations "which were previously difficult to standardise because there were no digital equivalents to mechanical drills, jigs and ships, all of which are required to create global supply chains in manufacturing" (2008: 138).

Innovation has been understood in many different ways and can take many forms and as Cornish (in Glass and Hayward 2001:572) points out, while there has been an emphasis on technological innovation, others such as social, organisational and institutional innovation may be just as important. Glass and Hayward in their study into innovation in the New Zealand boat building industry posit that;

> "Virtually all theoretical approaches consider innovation to be an essential element of economic growth. It may be defined as the application of knowledge to improve products or production processes. In this, the term 'application' is key, as innovation is to knowledge what capital is to a mere monetary stock: it represents its incorporation into the productive arena and so it is innovation as a social process that is of primary concern." (2001:573)

Writing from an educational perspective, Muller insists though, that innovation remains critical in a world of increasing international competition even though "the nature and practice of innovation is poorly understood" (2000: 30 – 31). Distinguishing between *knowledge-driven innovation* and *social practice driven innovation* (2000: 30 – 31), he shows how innovation is driven by research, development and technology transfer based on formal scientific knowledge. He also recognises a kind of "learning by doing" innovation where workers adapt to new work processes, incrementally changing and applying new technologies. Muller questions the usefulness of polarising the issue and suggests an alternate approach that;

"does not polarise 'knowledge' and 'doing', so much as distinguish between two necessary and complementary components of all knowledgeable activity: the coded innovative knowledge 'product' or result of the activity on the one hand; and the tacitly embedded unarticulated knowledge which is the 'process' condition for its productive realisation, on the other" (2000: 32)

2.4 A CONCEPTUAL FRAMEWORK

In the concluding section of this chapter, I attempt to develop what Bernstein (2000: 139) terms an 'internal language of description', a conceptual language that connects my research question to the established body of literature discussed in this chapter, and thereby allows the empirical investigation presented in succeeding chapters to be theoretically grounded.

Gamble (2009: 18) draws the distinction between empirically and non-empirically generated knowledge at the highest level as a 'particular-general' knowledge fractal, which is then repeated at the second level as a 'procedural-principled' knowledge fractal, with the two components co-existing in a complementary relation. These fractals appear on both sides of the fundamental division between the two knowledge forms, showing that each contains something of the other (2009: 12).

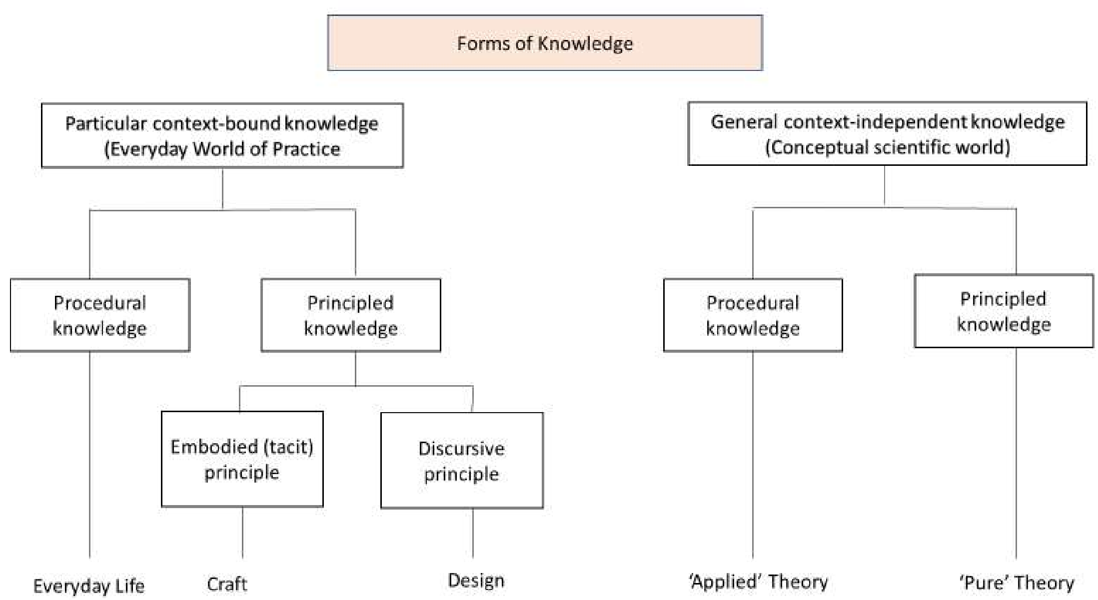

Fig 2: Gamble (2009) analytical model showing the division between knowledge forms

A second construct developed by Gamble (2016 a) which depicts knowledge types and was referenced earlier in the literature review, was also adopted in developing the conceptual framework.

	SITUATED KNOWLEDGE (Specific)	FORMAL KNOWLEDGE (General)
PROCEDURES	'How to' knowledge Work routines learned through everyday experience (not written down) K1	Systems knowledge Formally codified work procedures (written down) K2
PRINCIPLES	Craft knowledge (Principles visualised through drawings and sketches) K3	Scientific knowledge (Principles written down in symbols and words) K4

Fig 3: Types of knowledge in the vocational curriculum (Gamble, 2016 a)

Specific situated knowledge underpinned by procedure is strongly located 'in the world' and is reflected in everyday experience as 'how to' knowledge K1. This type of knowledge is not written down and is routine, as opposed to K2 'systems knowledge', which is written down and is learned as codified work procedures applied to practice.

Principled knowledge, or knowledge 'in the mind' in a situated context is practically acquired with an underpinning 'part whole' order of meaning evidenced through making drawings and sketches and termed 'craft knowledge' or K3. Formal principled knowledge, or K4 is 'scientific knowledge where the 'part whole' principle is formally learned with symbolic explication verbally and in writing.

Whilst acknowledging that vocational knowledge is complex, I take Gamble's (2016a) four-way conceptualisation of knowledge and reformulate it by operationalising a fractal and sub-fractal view of formal and situated knowledge and principled and procedural knowledge based on Gamble's (2009) schema shown above.

By synthesising the two conceptual frameworks the following knowledge framework is developed for this study:

Adapted Schema from Gamble (2016a)

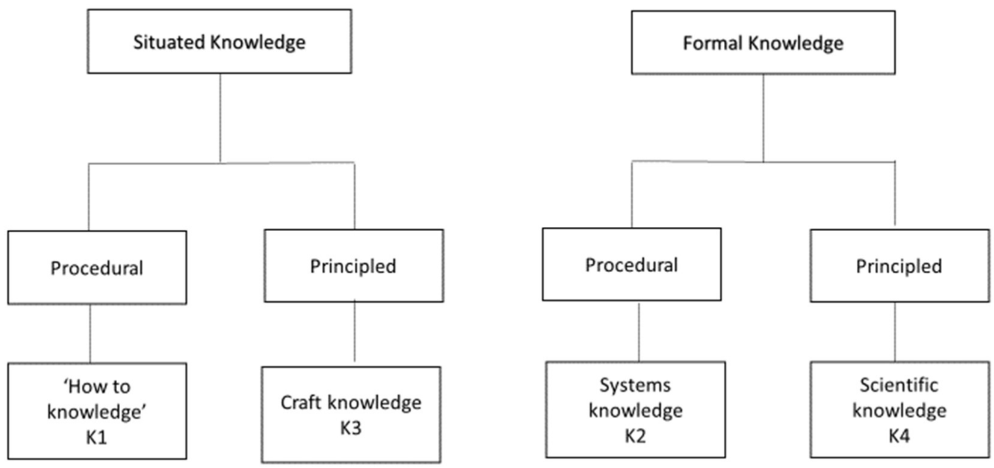

Fig 4: A conceptual knowledge framework (adapted from Gamble, 2016a)

It is important to note that the second knowledge construct developed by Gamble (2016 a) was applied in the Labour Market Intelligence Partnership (LMIP) research into knowledge based artisanal futures. I participated on the research team and the study turned to work itself, to its organisation and to the diagnostics and problem-solving found in the work of artisans and technicians. The demand-focused study undertook qualitative research studies into four industry sectors: Boat Building, Engineering, Film Production and Tourism and Hospitality. A sector report was produced for four different trades and I was responsible for the sector report for "Boat Builder and Repairer".

Whilst this thesis was first conceptualised in 2012, the subsequent LMIP research which concluded in 2016, influenced my adoption of the knowledge schema (Gamble 2016 a) as a lens from which to understand the concomitant drivers of innovation and reproduction in boat building. I explain this in the paragraph below and present a conceptual framework drawn from work itself.

As the empirical field of this study relates to boat building as a production process that is closely aligned with design. It is also an industry that rates innovation highly. At the same time, its products need to meet international quality standards stipulated to high levels of technical specification, as set by the International Standards Organisation (ISO). In knowledge terms, routine reproduction draws most strongly on procedural knowledge whilst innovation draws on principled knowledge. The diagram below depicts the relation between boat building as a production practice and boat building as a knowledge practice and illustrated the competing demands of reproduction and innovation.

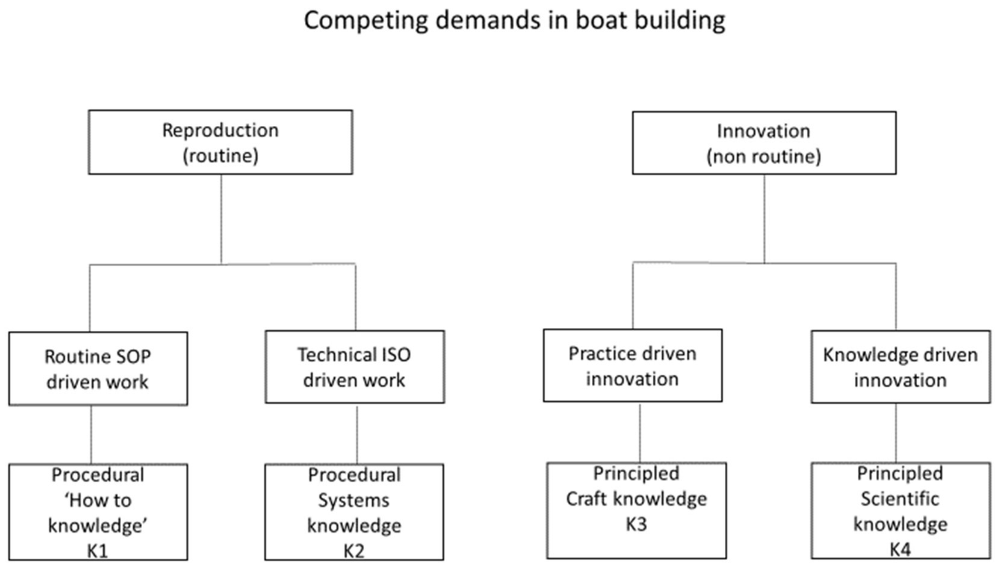

Figure 5: A conceptual framework drawn from boat building work

This relation will be explored in chapters 4, 5 and 6. Chapter 4 explores boat building as a production work process practice and uses the above model to distinguish between two main types of work organisation. Chapter 5 analyses a qualification specification for boat building to determine what types of knowledge, the formal qualification privileges. Chapter 6 turns to the practical component of the qualification to continue the knowledge investigation. The conceptual frameworks depicted in Figures 2 and 3 provide the overarching logic for the analysis offered in the three data chapters.

In the next chapter, I will look at the research methodology before the empirical data chapters.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This study employs a qualitative case study research design method informed by the two conceptual frameworks developed in chapter 2. Whilst this is an educational study, it locates itself very close to work itself and the occupational competence required for work. Using the conceptual frameworks developed in chapter 2, this study finds a common language to examine the unit standards and their underpinning knowledge types thereby creating a lens with which to research the link between work and qualifications and curriculum.

3.2 RESEARCH PHILOSOPHY

A social realist approach to education is the basis of departure for this thesis which seeks to understand the mix of formal knowledge and situated knowledge in a trade underpinned by work of certainty where the end result is pre-determined and work where the end result is not pre-determined and there are higher degrees of risk. This study is undertaken within the context of the dual demands of reproduction and innovation in the boat building industry in South Africa.

3.3 RESEARCH THEORY

The approach is conceptually informed by Bernstein's theories of knowledge structures, and the theorisation of everyday knowledge or "horizontal discourse" and disciplinary knowledge or "vertical discourse". Bernstein identifies inherently different structural differences between the two with strong boundary differentiation (2000: 156). Traditionally, Bernstein's work and methodologies have been used most often in studies into schooling and curriculum.

More recently, the Bersteinian approach has expanded into the vocational education field and social realist thinkers have brought to the forefront, knowledge requirements in vocational education and training (Young, 2008; Wheelahan, 2007, 2010, Gamble 2006). In particular studies have highlighted the need for the inclusion of disciplinary knowledge or what Young (2008) terms "powerful knowledge". Gamble's (2004) empirical work on craft and knowledge types in vocational education is central to this thesis which focuses on boat building as a vocational occupation.

3.4 CONCEPTUAL FRAMEWORK

Two conceptual frameworks, as outlined in the literature review chapter, are used. In order to operationalise a study into situated and formal knowledge and the dual demands of innovation and reproduction, it is necessary to adopt an educational knowledge construct and a labour process construct. Based on the dual needs of principled and procedural logic, or work of certainty and work of risk, the same sub-fractals are applied to both the knowledge construct and the work logic construct. Whilst work and knowledge are distinctly different and employ different lenses of analysis, this study aims to bring the two as close as possible to operationalise a conceptual framework that can look concomitantly at work and knowledge.

The study has three main data components: labour process or work logic, the qualification, and the enacted curriculum with respect to learning material and college workshop activities. The diagram below provides an outline of the logic of this thesis, and how the three main data components are used to answer the key question about the mix of formal and situated knowledge in a boat building curriculum.

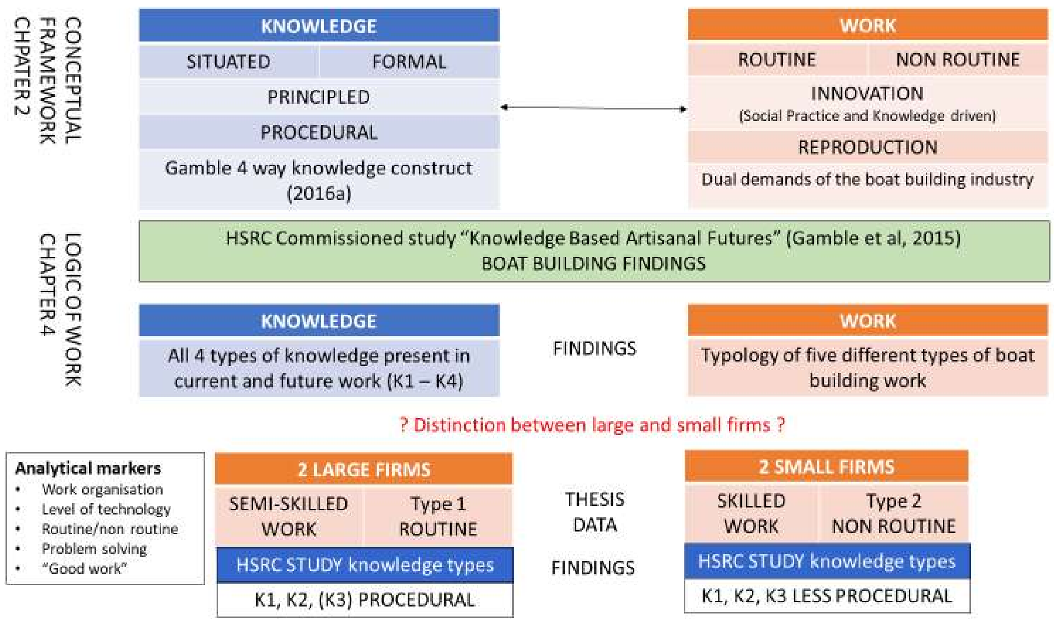

Figure 6: The structure of the thesis (Chapters 2 and 4)

Initially in the data analysis of Chapter 4 into the logic of boat building work, the knowledge and work components were conflated in the analysis of the large and small firms, using a mix of data from interviews and work observation. This initial conflation was subsequently changed because one cannot directly observe knowledge types in work processes. The HSRC knowledge constructs or "spider diagrams" were used as the "link" to then verify the work process observations in terms of knowledge types. This is shown in the juxtaposition of the 'orange' work process data for firms and the 'blue' HSRC knowledge types at the bottom of Figure 6.

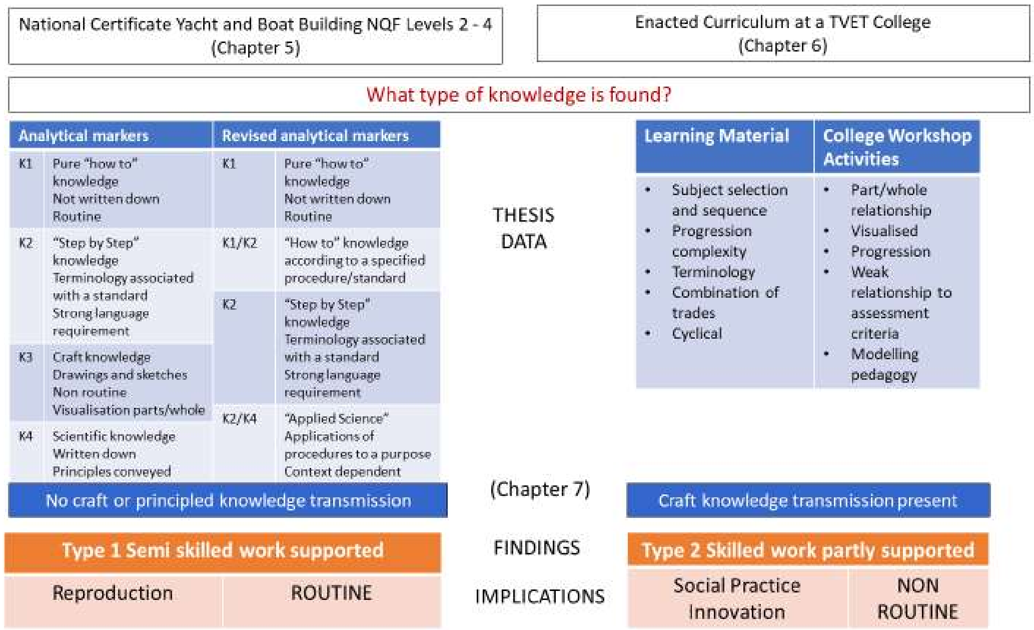

Fig 7: The structure of the thesis (Chapters 5, 6 and 7)

3.5 RESEARCH APPROACH

A qualitative research approach is adopted informed by the conceptual framework. The research concepts that required operationalisation were work of certainty underpinned by proceduralisation and work of risk, where the end result is not pre-determined and these most closely equate to the industry dual demands of reproduction and innovation.

3.6 RESEARCH DESIGN

The study is a qualitative enquiry that undertakes a detailed analysis of boat building work and the underpinning requirements for innovation and reproduction, and a detailed examination of boat building training provision at a TVET college. This approach is used because the thesis focuses on the juxtaposition of knowledge and work. The case study looks at the logic of work in large/medium and small boat building firms and the logic of the vocational enacted curriculum in terms of the practical workshop component.

The case study design comprises four distinct data sets. Firstly, the 2010 Yacht and Boat Building qualification (NQF 2 – 4) assessment criteria were analysed using the four part knowledge schema developed by Gamble (Appendix 1 & 2). Secondly the learning material was reviewed with respect to content and sequencing. The third data set was workshop and classroom observation and task identification at the TVET college (Appendix 3). Due to only one TVET college offering the qualification, the targeted respondents in this data set were prescribed. The fourth data set was industry work observation at one large and one medium firm and two small firms as part of the LMIP research study. The selection of large/medium firms was based on who first responded to the request for access. The selection of small firms similarly was based on whether industry was prepared to allow access and one company was located in the Western Cape and one in the Eastern Cape.

It must be noted that the industry is relatively small in South Africa and as a researcher my close positionality and established relationships influenced the fourth data set. Whilst this is a limitation to the study, it also afforded access to a data set that would have been difficult for an "outsider" to access.

A case study is useful because I "deliberately want to cover contextual conditions" (Yin 1994: 13) in the study and a case study allows a detailed investigation of both curriculum and work; two different and often divergent areas that are often studied separately and rarely investigated together.

There are limitations to a case study research approach and Geering (2011) identified some of these as "loosely framed and non-generalizable theories, biased case selection, informal or undisciplined research designs, weak empirical leverage, subjective conclusions, non-replicability and causal determinism". On the other hand, the strengths of a case study enquiry according to Yin (1984: 13) are that it copes with "technically distinctive situations", "relies on multiple sources of evidence with data needing to converge in a triangulatory fashion" and it "benefits from the prior development of theoretical propositions to guide data collection and analysis".

3.7 DATA COLLECTION TECHNIQUES

The initial data collection for the study included: industry work observation, industry interviews, classroom observation, learner interviews, lecturer interviews, college workshop observation, the qualification and the learning material.

However, as the theoretical constructs used for this study created a narrower focus than originally anticipated, the final data used includes:

Work observation at four work sites (data collected for the HSRC study into artisanal work[1])

Two small firms (11 February and 19 February 2014)

Two large/medium firms (20 March and 26 March 2014)

College workshop observation (22 March 2012 and subsequent unstructured informal observation)

National Certificate Yacht and Boat Building (SAQA IDs 77003, 78863 and 78864)

Boat and Yacht Building Learner/Activity Guides NQF Levels 2, 3 and 4 (developed by merSETA)

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[1] In 2012, the Human Sciences Research Council (HSRC) in partnership with the Department of Higher Education and Training launched the Labour Market Intelligence Partnership. Focused on providing credible labour market intelligence, the partnership was organised around six themes. Theme six "Understanding changing artisanal and occupational identities and milieus" commissioned a number of studies and I contributed to the study on 'Knowledge based artisanal futures' with a focus area on boat building artisans (Gamble J et al: 2015). The study looked at work categorised in terms of risk and certainty and linked to knowledge forms. For the boat building component of the study, one medium, one large and two small boat building firms were studied. With the permission of Gamble, my work observation data at the four sites is used in this study in the analysis of the labour process and the identification of two main types of work; skilled and semi-skilled.

3.8 DATA ANALYSIS

Four methods of analysis were employed to analyse the data.

Method	**Analysis tool**
1. Qualification analysis	Coding verification of assessment criteria and allocation of knowledge types.
2. Learning material review	Review of content, activities and summative and formative assessments.
3. Workshop observation and task identification	Unstructured observation. Notation. Unstructured interviews.
4. Industry work observation/participant observation	Critical incidents. Notation. Photographs where applicable. Particular focus on problem solving.

Table 1: Methods of data collection and analysis tools

3.8.1 Qualification analysis

The analysis of the qualification is based on the knowledge type schema developed by Gamble (2016a) with four knowledge forms, K1 – K4. I use this schema in Chapter 5, in the analysis of the qualification by focusing on the assessment criteria of the unit standards. Because one cannot see knowledge in the qualification itself, we can only look at what is assessed and examine the evaluative criteria.

In the first stage of coding verification, a definition of each knowledge type of K1 – K4 was applied to the assessment criteria of those unit standards directly relating to boat building. Due to the findings of this first coding exercise, a second coding schema was developed. A coding sample of this adapted analytical tool was verified by my supervisor and then an independent 'outsider' was asked to code 'cold' using the coding categories below.

Examples from the coding exercise to indicate how the knowledge types were allocated:

Assessment criteria NQF Level 2	Knowledge type
Measuring and marking equipment is used in boat building	K1
The metal plate is mounted according to specifications	K1/K2
The different types of adhesives are explained according to product specification	K2
The main features of a lines plan are explained focussing on boat design principles	K2/K4
Assessment criteria NQF Level 3	Knowledge type
A propeller is examined for damage	K1

Shapes are lofted from a lines plan according to boat building standards	K1/K2
The installation, maintenance and use of marine plumbing systems are explained with specific reference to national and international standards	K2
Resins used in boat building are explained focusing on the physical property data of composite marine products	K2/K4
Assessment criteria NQF Level 4	Knowledge type
The operation is performed safely and within the time allocation	K1
A simple marine electrical system is correctly installed with appropriate wiring which functions according to design	K1/K2
The preparation of the boat surface is explained in accordance with the coating system manufacturer's specifications	K2
Different aspects and features of small craft rig design are described and their implications for sailing performance discussed	K2/K4

Table 2: Sample of knowledge type allocations according to individual assessment criteria

(Full analysis in Appendix 1: "Yacht and Boat building elective and core unit standards, specific outcomes and assessment criteria: full knowledge type analysis")

3.8.2 Learning Material Review

The Boat Building learning material was reviewed in support of the workshop component analysis. The material was designed and developed by TLN Performance Systems on behalf of the merSETA with industry input and expertise used via small working groups.

3.8.3 Workshop observation and task identification

Formal workshop observation took place on 22 March 2012 and unstructured interviews were conducted with the two College Lecturers to ascertain the project tasks selected for the practical workshop component of the course.

3.8.4 Industry work observation

The HSRC study work observation schedules were used, and five analytical markers were extracted to ensure relevance to the knowledge comparison explained on page 18. The original work observation schedules were developed by the HSRC research teams and permission was given by my Supervisor to use the data. All references to firm names, participant names and other identifying data have been removed to try and ensure anonymity of the sites.

3.9 LIMITATIONS

The use of a qualitative approach has allowed me to provide a strong contextual and descriptive base to the study, however, this can have negative implications for reliability and validity. The internal validity of this study is based on literature and work done in the area of knowledge in vocational curricula. The construct validity, or the measurement variables of the four-way knowledge construct and the analytical markers were used to improve the construct validity of the study, although there is a weaker construct applied to the analysis in Chapter 6, which I acknowledge and could be improved upon. The external validity, or the degree of generalisability of the work logic component of the study, has a certain strength in that large and small firms are held up against each other, although the sample size is relatively small with just four firms being examined. However, should an attempt be made to replicate the study with a similar vocational qualification, I feel that the large and small firm distinction would be valid enough to ensure a level of generalisability.

The literature on positionality in qualitative research is vast. The nature of qualitative research means that the researcher is also the data collection instrument. 'Research as observer' leads to particular challenges in a study. As a qualitative researcher I have been very close to the subject matter and therefore my beliefs, and many other factors have influenced the research process. This inherent problem of being close to one's subject matter is an area of debate in the 'insider' 'outsider' literature. Merton defines 'insiders' as "members of specified groups and collectivities or occupants of specified social statuses: Outsiders are non-members" (1972: 21). My lived familiarity with the boat building sector and my a priori knowledge of many people in the industry clearly locates me as an 'insider' in this study. Some of the advantages this position has afforded me is; easier access, the ability to ask more meaningful questions, an ability to understand the broad technical terms and processes and being trusted. The disadvantages are that I may have been unknowingly biased, been too familiar and close to the topic, unable to ask certain questions, and unable to bring a truly external perspective to the process (Merton, 1972).

Bearing in mind this ontological and epistemological bias that underpins the very study itself, I have endeavoured to bring a reflexive consciousness to my study. I have also had to be aware that this thesis was conducted over a five-year period and that my positionality has changed over time. What I have attempted to do is to bring self-reflection and to disclose where I have, or may have, influenced the research. Having said that, reflexivity is not a panacea and it can't guarantee 'truthful' research.

In the face of being unable to eliminate positionality, I attempt to document my influence on the study. The work of Savin-Baden and Howell Major (2013: 71) provides a useful lens for looking at positionality. Firstly, from the perspective of the subject, secondly from the perspective of the participants and thirdly from the perspective of the research context and process.

3.9.1 The subject

I have worked in the boat building sector for nine years, in various roles in the industry association. I was involved in the re-writing of the Yacht and Boat Building qualification in 2010, as the industry felt that the initial Small Craft Construction qualification written in 2006 was not meeting their skills needs (COFISA Report, 2009). As result, I have a 'vested' interest in the qualification. On the one hand, I wanted the 2010 revision to "fix the problems" with the qualification and I may not have been sufficiently critical. On the other hand, my interest was piqued as to why even after a second attempt, the qualification was still reported to me, as the industry association representative, as problematic. This led me to my research focus and my interest was further piqued when I learned from German industry association colleagues that they were finalising a Boat Technician qualification in 2012, to build on the existing well-established boat building apprenticeship in Germany. This provoked my thinking about technical developments in the industry. I have continued to be involved in qualification development in this sector and I have been involved in the development of a boat building apprenticeship (as differentiated from a learnership) over the last three years. My bias in favour of employer needs for appropriately skilled staff is a limitation of the study. The measures I have taken to mitigate the bias is to locate the study clearly in a body of literature on the logic of work, knowledge types and curriculum.

3.9.2 The participants

Being an 'insider' gaining access to the participants on the study was not problematic. I interviewed employers, professionals, learners and teachers but the data gathering was not direct and purposeful. As I knew all the people being interviewed before I commenced the study, there were prior assumptions from both myself and the participants as to my role, my opinions and the possibility of other influences, on the study. Hypothetically, a learner might hope that by responding in a certain way, his or her chances of finding employment in the industry might be increased.

Using open-ended interview methods is a limitation of the study as it difficult for me to supply a rationale for the questions. As a researcher I was guided by the interviewee's responses and endeavoured not to ask leading questions. This limitation of being an 'insider' I believe is out-weighed by the benefits of participants freely sharing their opinions and giving me a significantly greater portion of their time. An independent 'outsider' researcher is unlikely to have been given this opportunity.

3.9.3 Research context and process

In the process of conducting the research, I participated on the LMIP research project into artisanal work of the future commissioned by the HSRC, on request from the Department of Higher Education and Training. Boat building was one of four vocational occupations chosen for the study and I completed the study on boat building. With Gamble's permission, this data is included in my study and I have extended some of the findings from the original study. This participation has added to the depth and maturity of my study and it provided an important conceptual tool for part of the data analysis. On the other hand, the study has also influenced my original research question as it has introduced the juxtaposition of work and curriculum

.

3.9.4 Conclusion

I have attempted at all stages of the research process to bring rigour, accuracy and ethically sound judgements to the study. The outputs of the study are not presented as 'the truth' and may not even be replicable, but they are a truthful and honest presentation from my epistemological standpoint outlined above.

3.10 RESEARCH ETHICS

Written permission was sourced for the work observation at the four boat building sites. Names and references that may allow the reader to infer the names of the companies have been removed, although company anonymity cannot be guaranteed as the industry is relatively small. Written permission was also sourced from the TVET college for the study. As it is the only TVET college offering the Yacht and Boat Building learnership, its anonymity also cannot be guaranteed although the college is not referenced directly in the study.

The following three chapters present the labour process, qualification and enacted curriculum findings from the study.

CHAPTER 4: THE WORK OF A BOAT BUILDER

4.1 INTRODUCTION

In this chapter, I investigate the work of a boat builder utilising data I sourced from work observations I conducted as part of the HSRC study into artisanal work of the future (Gamble et al, 2015). Firstly, I review and extend the work of the HSRC study into exemplifiers of large/medium and small boat building work sites. Secondly, I identify and corroborate the findings of two occupational variations in the work place; the work of a semi-skilled worker, largely found in large/medium firms, and the work of a skilled worker more commonly found in small firms.

4.2 THE LOGIC OF BOAT BUILDING WORK

In seeking to understand how formal and situated knowledge is transmitted in the boat building industry, it is important to focus on work itself and the occupational competence required for work. Whilst it was hoped that the development of a competence-based qualification would ensure relevance for the workplace, in fact, the generation of a CBMT qualification comprising unit standards with their associated structure and complex language, takes us several steps away from work. Whilst the boat building qualification was developed by 'industry subject matter experts' based on what actually happens in a boat building yard, in the "translation" to the pedagogic arena, the discursive gap has widened. Therefore, there is a need to find a common language with which one can understand labour process and a unit standards-based qualification. This study develops a heuristic lens to look at boat building work and a boat building qualification by applying the underpinning theoretical construct as outlined in the concluding paragraphs of the Literature Review.

4.3 THE HSRC KNOWLEDGE TYPE FINDINGS

The HSRC study (Gamble et al, 2015) turned to work itself, to the organisation of work and the problem solving inherent in the work of artisans. Part of the study sought to understand the type of knowledge used in boat building yards.

Boat builders in the HSRC study identified the global economic climate as the factor most affecting business growth, and both large and small firms prioritised innovation. For large firms' innovation is driven by improved design capabilities reflecting their stronger resources whilst small firms found ways to work more smartly.

At a more general level the HSRC study found three universal trends across the artisanal milieus of study. Firstly, the labour process attempts to minimise risk and wastage and increase the certainty of work and the predictability of the end result. This minimisation of risk is achieved through standardisation of work routines with an increasing role played by mechanisation and digitisation. Secondly, the study found an increase in the coding of work routines by writing down Standard Operating Procedures or SOPs. These SOPs increasingly lean towards a universal benchmark of standardisation globally. Lastly there was an opposite trend towards product innovation to increase and maintain market share for products.

Figure 8: HSRC knowledge types for boat building now and, in the future,

The HSRC study found a mix of all four types of knowledge present in boat building, both now and in the future, for both large and small firms. Specific situated procedural knowledge, that is not written down, is seen as slightly more important. However, in future, a deepening of formal principled knowledge and formal procedural knowledge is anticipated. The study found simultaneous trends of work standardisation through mechanisation or digitalisation, the coding of work into Standard Operating Procedures and a drive towards product innovation to maintain or increase market share. In boat building this is reflected, in future, by an increase in general procedures (Standard Operating Procedures) driven by global standardisation. There is a similar increase envisaged for scientific knowledge that is 'written down', indicative of up-skilling and a trend towards more science-based knowledge. Craft or 'how to' knowledge that is situated and not written down, is also seen to increase in future, although not quite as much.

This aggregate report masks the differences between labour processes in large and small firms and this study continues exploration into the firm size distinction that is set up in the HSRC report (Gamble et al, 2015).

In terms of formal knowledge, large and small firms agree that there will be an increase in General Procedural knowledge and General Principled knowledge. This is indicative of a move towards greater standardisation in line with international norms and there is a clear and marked increase in the formal explicit knowledge base of boat building anticipated in both large and small companies. This also supports the notion of a need to "talk the same technical language".

The picture for situated knowledge is different and variations emerge between large and small firms in terms of labour process. In an industry which has historically trained for itself, two distinctions emerge between large/medium and small firms. In large/medium firms there is a backbone of semi-skilled staff and a more specialised division of labour that is determined largely by the materials the worker is using. In small firms there is a much stronger emergence of all round general boat builders who can problem solve, reproduce and innovate.

In part conclusion, overall companies indicate in future there will be a move to a more evenly balanced knowledge base for boat building. However, the differences between large and small companies with respect to situated and principled knowledge variations illustrate the emergence of two different types of labour process. What I have termed, a type 1 semi-skilled labour process that is procedural, linear and sequential and a type 2 skilled labour process where the end result is not pre-determined, and the labour process sits at the site of struggle between craft and standardisation.

To give this study more salience, and to close the gap between knowledge and work, I decided to investigate the logic of boat building work in terms of standard definitions of work processes for skilled and semi-skilled work. How I arrived at the definitions for skilled and semi-skilled work is explained below.

4.4 THE OCCUPATIONAL VARIATIONS OF BOAT BUILDING

As part of the HSRC study (Gamble et al, 2015), I generated an occupational profile for boat builders. However, what was clear was that the combinations of the four types varied enormously across companies in terms of size, nature of production and management style. At best, the profile below is a theoretical exemplifier. Type 5 "master" boat builders are few and typically they are also the owners of the company. The Type 4 technician, is not easily observable and is largely driven by technical suppliers and new product developments. The Type 3 boat builders, is the aspirational boat builder for whom the boat building qualification was developed, whilst the Type 2 artisan was envisaged to be qualified by recognition of prior learning, to create parity with the Type 3 boat builders. The Type 1 semi-skilled worker is a strong labour type in the boat building sector. So, in reality what starts to emerge is two types of labour process, one skilled and one semi-skilled and a management component.

Type 1 (Semi-skilled)	**Type 2 (Artisan)**	**Type 3 (Emergent and Imported)** **3a) Junior** **3b) Senior**	**Type 5 (Professional)**
Assistant/Semi-skilled worker Works with hand tools on basic repetitive tasks. Materials define the work. Follows instruction closely. Closely monitored at risk moments. Specialised to a task/function.	**General qualified artisan with OTJ specialisation in boat building.** Generally working with power tools and drawing interpretation. Contextual specialisation in marine environment eg. marine carpenter, marine fitter, marine fabricator, marine pattern maker. Multi-skilled, can do different tasks within a	**Boat builder cross skilled knowing the whole boat** Craft based (aspirational). Marine environment specialisation. Multi-skilled, understands all tasks and can visualise end product in context. The only one where industry has invested in formal training. Formal knowledge base and employs relational logic. Years of OTJ experience.	**"Master" Boat builder** Business, production, technical and design oversight. Links work of all types. Oversight of materials, quality and performance. Manufacture/Design interface. Often enters via other professions eg engineering/architecture.

Can move horizontally to other industries doing the same tasks. Trained on the job.	team context. More likely in a small company. Can apply knowledge and therefore can problem solve in a new way. Move within the industry	Has supervision role or structural component assembly role. Level of autonomy.	
		Type 4 (Technical)	
		Boat building technician Intermittant. Sometimes outsourced. Did not show strongly in the sites, but it is emerging. Systems and marine context specialisation. Strong knowledge base gained in different ways and significant OTJ experience. Generally work on systems installation and repair. Problem identification and solving. Employing strong relational logic and formal knowledge. Work strongly determined by tools, equipment and materials.	

Table 3: Forms of labour process found in boat building (Gamble, J. et al, 2015)

In order to verify this supposition, the next part of the study examines skilled and semi-skilled differentiation by analysing a synthesised picture of work observations at small and large/medium firms.

In order to contextualise what I mean by firm size; in small boat building firms there are typically between 10 – 50 people are employed. This means that at various stages of the boat building process different skills are required and ideally an employee who can work with different materials and different skills sets at various stages is advantageous. In a large/medium firm there is a different picture, with 50 – 1000 people employed all with very specific jobs fitting into the production process, where none of them are called boat builders. Experienced staff may well call themselves boat builders but generally their job categorisations would be job specific, such as “mechanical fitter”, “laminator”, “finisher”.

For the study one medium (A), and one large firm (B) and two small firms (C and D) were analysed. The findings below are a condensed descriptive view of the labour process ascertained through work observation. The following markers were used in the analysis: work organisation, level of technology, routine/non-routine work, problem solving and what is defined as “good work”.

4.4.1 Large/Medium firms

Site A Work observation

Site A is a well-established medium to large size company which specialises in aluminium construction. Health and safety is taken seriously by all the staff and everyone wears ear plugs and safety glasses. The environment is very noisy, and staff often communicate with signs.

Work organisation: Work is procedural, and the job of the welder/boat builder is critical in the build process. The drawings dictate exactly how the build process takes place. For example, there are international rules for construction and the Operations Director oversees this work. Work is organised around materials and the build process. The welders work in teams and individually. At places where the work is more complex or risky there are more artisans allocated to the job under the supervision of a more senior staff member. The design of the boat influences the entire work organisation.

Level of technology: The type and level of technology are not a strong basis for work organisation at Site A. The basic principles of aluminium construction remain the same, but the complexity is driven by the design which requires artisans to work in smaller spaces or with more complex welding arrangements. There is no automation except for overhead gantries and the welding hoses run directly from the welding machine. Working with metal and heavy weights, there is a lot of hammering and banging to position pieces of aluminium before measuring, checking and finally welding a seam.

Routine/non-routine: Most of the day's activities are routine. The unexpected seems to be when measurements do not agree with the drawings and specifications. This slows work down and involves supervisors and double checking. I see people using string, levels, T squares and tape measures at various points during the day. Only once everyone is one hundred percent certain the problem has been resolved does work continue.

Problem solving: Diagnosis and problem solving happens throughout the day, as described above. It involves reference to the drawing, measuring, drawing, checking and measuring again. It involves the artisan and a supervisor and sometimes a second artisan.

What counts as good work: The right attitude and "not being playful". Being focused and completing work accurately. Not making mistakes. Taking all the health and safety precautions.

Site B Work observation

Site B is a large production boat building company. Work observation is done at the Head Office and main branch of the company. There are "work stations" as the boat moves through the production process. Each "station" has between 8 – 15 staff allocated to it and the staff report to a Group Leader. The Group Leader in turn reports to the Team Leader. Thereafter, there is a line manager, an assembly manager and a production director. The boats are housed in a cradle and moved to the next work station by pushing the boats down the line. When the boat is complete and has been through quality control it is lifted onto a trailer and transported to the harbour where it is lifted by crane into the water. Thereafter the boat is "commissioned" and final checks and handover completed.

Work organisation: Work is organised along production principles and is strongly procedural. Sequencing and pacing is clearly defined also there is variation in the sequencing due to a range of variables such as "shortfalls" or others not completing a prior task. The job of a "boat builder" per se does not exist in this company. However, the Group Leaders were of the opinion they were boat builders due to the longevity and wide range of experience they had, having worked in the company for many years. When I asked the carpenter, he responded "I am a boat builder. A boat builder must have a wider knowledge and I started in the primary section". He then went on to qualify the statement by saying "It is not boat building anymore, its finishing carpentry and installation." There is a clear and defined work process in this company. The factory is set up to process boats with maximum efficiency at least cost. Staff continually refer to "hours" and production deadlines. The overall pace of work is fast. People move quickly but carefully and whilst there is a team ethic, there is also a strong sense of individual responsibility. The work is defined by the task sheets developed and overseen by management. The artisans call the task sheets "the bible" and the team leader tells me "you mustn't do your own thing".

Level of technology: There is a fairly simple level of technology used as the basis for work organisation. For example, the moulding shop employs hand layup techniques rather than using more advanced technologies. The tools observed on the boat are traditionally what are used in other boat building yards such as drills, grinders, jig saws, hammers etc. The carpenter commented "Time has moved on to a different level and technology will play a bigger role". As an example, he referred to the use of laser to mark waterlines on a boat. This could not be verified by observation, but it appears there are small jumps in technology as and when they become available and cost effective.

Routine/non-routine: All of the work is routine and prescribed. The unexpected occurs when problems occur somewhere along the production line. Sometimes the problems go by without being noticed, sometimes they are ignored and eventually they are picked up, either by a responsible artisan or in the Quality Control bay. The carpenter explains to me that problems vary on the boats and that you cannot always say where the problem occurred. The carpenter makes an insightful comment "We used to be competitive on defects when we handled more of the building process". While the move has been to specialisation of tasks it appears at some level to be counterproductive in terms of problem risk mitigation

Problem solving: Diagnosis and problem solving is largely the responsibility of the team leader and group leader. The do not physically work on the line, but they are responsible for identifying problems and effecting the solution. I could not observe how often it happens but inferring from the observation regarding defects, it is a continuous process. There is a sense that artisans want to do things themselves because then they know that the work has been done correctly.

What is good work: Accurate work to production schedule task descriptors. Being present at work and not being absent. Taking responsibility and being self-directed in your work. Being accountable. Knowing how to work with your tools and having the right tools for the job.

4.4.2 Semi-skilled labour process

In the large/medium firms, what emerges from the observations above, is a strongly situated and procedural labour process dominated by Standard Operating Procedures and high levels of technical specificity. Here the work process is specialised to a task or function and the materials and tools very closely define the type of work. Work tends to be repetitive and follows a particular sequence. This is what I term a type 1 boat builder, or a semi-skilled worker, where the labour process is linear, sequential and procedural. Speed, accuracy and dexterity are markers of "good" work and everything is undertaken according to the SOP or design specification. There is a strong contextual and "common sense" knowledge characteristic that arises when examining the type of knowledge required for Type 1 labour processes.

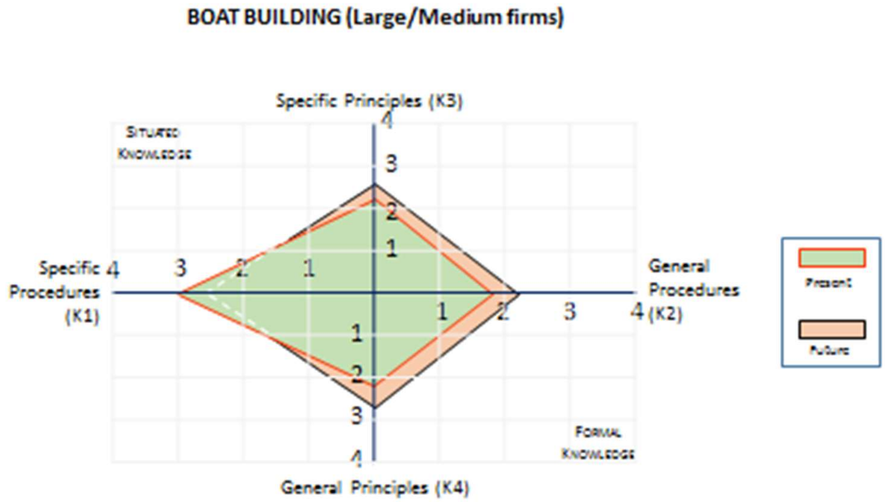

Fig 9: HSRC knowledge types in large/medium firms, now and in the future

When one takes the labour process observations above and hold them up to the knowledge types found in the HSRC study into large/medium firms, there is corroboration between work processes and knowledge types envisaged in the future for large/medium firms. The stronger K2 general procedural knowledge is reflected in the procedural work that is strongly organised around materials and build processes to a clear standard, task sheet or SOP. There is also an increase envisaged in principled K4 knowledge in future. Whilst the work observation showed that technical levels remain low, both sites noted that problem solving is continuous and always referenced to drawings, showing that an increase in principled understanding would improve problem solving and thereby improve final quality and cost-effective production time. Linked to this is the increase envisaged for K3 specific principled knowledge where there is uncertainty of end-result. In order to improve semi-skilled workers problem solving ability, this type of knowledge would better equip them to move between routine and non-routine work, with better levels of certainty of outcome.

The study now turns to small firms and work observed at Sites C and D.

4.4.3 Small firms

<u>Firm C Work observation</u>

Site C is a small firm employing less than ten people and producing recreational fibreglass power boats. There are three main work tasks on the day of observation. The cutting up of a deck plug (A plug is a tool from which you take a mould and from a mould a product can be made). The sanding of the deck mould (as referred to above). The fitting and cutting of one bulkhead template.

How is work organised: The factory space is small with boat moulds taking up most of the space. There are rigging points on the roof for lifting things. There is one work bench which is the supervisor and artisan's domain. Importantly there is a thermometer mounted on the wall, to indicate ambient temperature which affects the rate at which fibreglass catalyses and cures. There is a defined fibreglass cloth cutting area. At first glance it seems slightly chaotic but, after observing work, it is clear the workshop is logically laid out and people can generally find what they are looking for. The work is determined by the build process and all the workers appear accustomed to this. There was no sense of urgency and it was interesting to observe the juxtaposition of "rough destruction" of the mould next to the high attention to detail sanding of the mould. Both proceeded at roughly the same pace and there was a sense that mitigating risk moments (not preparing the mould correctly, cutting into the hull of the boat, breaking jigsaw blades) was the catalyst in determining the pace of work. I observed that jobs can "go down" but they can't "go up" without years of experience. For example, the assistant is given an opportunity to use the power tools under the guidance of the artisan during the first two hours of the day. After that, he goes back to the sanding work. The artisan can "go down" from using power tools and building templates, to sanding a mould.

Photo 1: Sanding the deck mould

Level of technology: On the mould sanding job the only tools were a sanding block, a bucket of water, a scraper, a brush and four different grits of sandpaper. There appeared to be a hierarchy with tools and their usage. The supervisor on three occasions took charge of "repairing" the power tools, either replacing a plug or tightening a shaft to minimise movement. The artisan was given free access to the power tools, but he did not assume any technical responsibility for them. The assistant was only allowed to use power tools under the artisan's supervision, but he was required to blow compressed air on the tools to stop them getting clogged with fibreglass dust. The women working on the mould sanding job only had access to the hand tools. The one power tool job undertaken on the mould was done by the artisan under direct supervision.

Photo 2: Fitting the bulkhead template

Routine/non-routine: At face value, the day all seemed routinized, but it was only on closer examination or asking the artisan that I could identify moments of risk. For example, the risk associated with using power tools. The other risk which is more implicit but understood by those working on sanding the mould, is that if this is not done correctly, the entire hull surface will be compromised on de-moulding.

Problem solving: The supervisor definitely had the upper hand with problem solving and diagnosis. He maintained an overview of the work space. Observing him working independently on the cutting up of the deck mould, he was spatially more aware than the artisan. The supervisor made an interesting comment whilst I observed him cutting up the deck; “Got to be ruthless and wild with this stuff, but careful on the other hand”. The supervisor had a much stronger relational logic than the artisan. As he worked on cutting up the deck he was clearly examining the work in a different way, looking underneath to see the structures before picking up the jigsaw to cut. The artisan on the other hand knew the tools and the end result needed but approached the job with less finesse resorting to the sledge hammer and wrench more often than the supervisor did.

What is good work: Adequate work pace. Not talking too much. Responding timeously to requests. Not damaging equipment. Keeping the workplace tidy. Both the artisan and the supervisor undertake hard physical labour in cutting up the deck mould, yet they do not strain, and they use the tools effectively. I assume this effective use of tools to get the job done is part of what counts as good work.

<u>Site D Work observation</u>

Site D is a small boat building company producing catamarans (twin hulled vessels). During work observation they are ‘tooling’ for two new models. The boat builder says knowledge of materials and temperature is critical. He has a dedicated resin mixer to mitigate the risks involved with mixing resin and that staff member is responsible, for example, for servicing the scale to ensure its accuracy.

Photo 3: Section of a boat building factory

How is work organised: This yard has four distinct areas of work on the day of observation. There are a team of three fairers, fairing the hull with a longboard and applying paste. The second team comprises two laminators working on a mould. The third team comprises two boat builders working on the deck mould. The fourth team is one person working alone on the construction of a "strongback" for the next phase of tooling. The master builder has complete oversight of all the teams and he divides his time overseeing everyone's work. The master builder is the link in discrete areas of work on this particular day of observation. The staff all know where the various processes fit into the procedure of tooling and mould building, but they are working on different areas. Although I did not ask the question directly, there is an implicit assumption that the more skilled staff will work at all levels if required. The less skilled staff, such as laminators and fairers, will very slowly be given more responsibility if they show the aptitude, but risk moments are clearly defined and monitored. "Work and clean" happens with all the teams and work stations all day. Cleaning is not left to another person and as each team reaches a certain point in their work, there is a pause moment to sweep or wipe or put waste material in a bin.

Photos 4, 5 and 6: Fairing a hull, Tooling foam for a mould, Boat building factory

Level of technology: As this is the tooling phase of boat building, there are a mixture of simple hand and power tools being used. The deck mould used a “vacuum” process to bond down the core yesterday and the two-man team are removing the bag and starting to tool the foam core. Jigsaws, grinders and routers are used. There is close reference to drawings and close measurement of this work. An error at this stage can have big consequences later if an error is made.

Routine/non-routine: Risk moments have supervision, discussion and reference back to drawings by each of the four teams.

Problem solving: Diagnosis and problem solving largely takes place at the tooling station, using a drawing as a guideline. There is also problem solving with team discussion.

What is good work: Accuracy. Knowing how to work with materials and equipment efficiently. Interpreting instructions and drawings. A constant pace with due regard to quality of product. Teamwork where needed.

4.4.4 Skilled labour process

What is apparent in the small firms is that knowledge of the entire construction process is needed by a greater number of staff and that the skilled labour process happens alongside the semi-skilled work and they are not mutually exclusive. The ability to see the ‘parts and wholes’ of boat building and how it all fits together, means that a skilled artisan can work at a number of levels and in a number of different technical areas. Efficiency, knowledge of materials and equipment and accuracy are some of the markers of good work in a small firm.

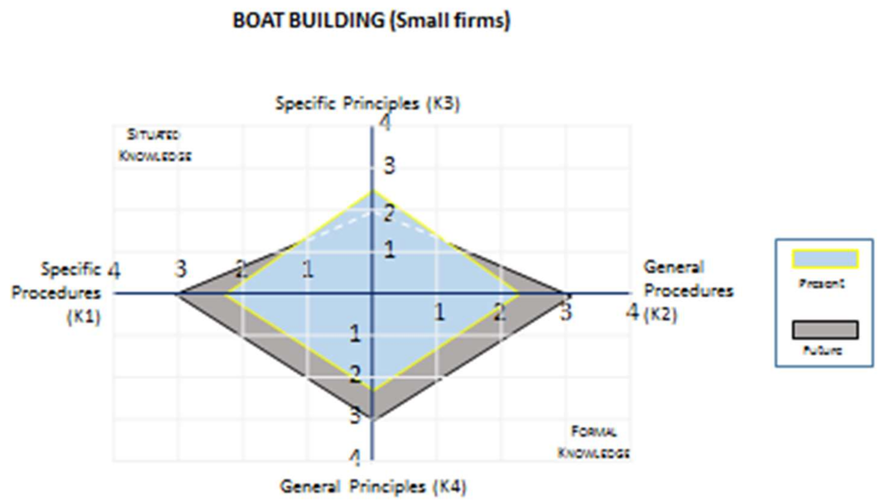

Fig 8: HSRC knowledge types in large/medium firms, now and in the future

When one takes the labour process observations above and look at them in terms of the knowledge types found in the HSRC study into small firms the following points emerge. There is a future emergence of both stronger work of certainty both for situated and formal knowledge reflected in the K1 and K2 knowledge increase. This proceduralisation is the same as for large/medium firms but it is more strongly reflected in small firms. There is also a deepening of principled knowledge understood in abstract or symbolic terms. This is very difficult to identify in work processes and can only be inferred as a future requirement to deal with more skilled work and technological advancement. Interestingly in future, small firms see a decrease in K3 or craft knowledge where there is uncertainty of end result. In work process observations, craft knowledge was observed, however it is closely monitored with supervision and is mitigated by continuous reference back to drawings at "risk" moments.

In conclusion, the concept of all round knowledge and an ability to perceive the relationship between 'parts and wholes' defines the labour process at a skilled level and problem solving is the driver behind this skills acquisition process, although it is led by the supervisor or master boat builder.

4.5 CONCLUSION

In other words, there are distinct differences between the type of knowledge needed. On the one hand, the skilled boat builder who needs to understand the entire build process and the relationship between the various parts relative to the end-product and the semi-skilled boat builder who undertakes part of the work and follows a standardised procedural labour process. This study finds that a semi-skilled work process is most often identified in a large/medium firm and that a skilled work process is most often identified in a small firm.

Based on the findings above, a summary table is presented below to compare the type 1 and type 2 labour processes with respect to reproduction and innovation and routine and non-routine work.

		Type 1 Semi-skilled (Routine work)	**Type 2 Skilled** (Non-routine)
Reproduction	Routine SOP work (K1)	High	High
	Technical ISO driven work (K2)	Low	Medium
Innovation	Practice driven innovation (K3)	Low	Medium
	Knowledge driven innovation (K4)	Nil	Nil

Table 4: Comparison of Type 1 and Type 2 labour processes with respect to routine and non-routine work

Both skilled and semi-skilled work is dominated by a high level of routine work, although the technical specificity of routine work is lower, with both large and small firms exhibiting low levels of technology and simple work processes. Non-routine work and problem solving is more apparent in skilled work, but it is seen in semi-skilled work where supervisors or more artisans are allocated to a job to solve the problem.

According to the HSRC findings (Gamble et al, 2015) all four knowledge types are required for a boat builder. However, what the analysis above finds, is that K1, 2, and 3 only appear in a Type 2 skilled boat building labour process. A Type 1 semi-skilled boat building labour process only shows evidence of K1 and K2 and an emergence of K3 according to the fieldwork observations above. Neither skilled nor semi-skilled work processes showed any general principled knowledge application on the shop floor. The closest reference to principled arrangements is seen in the reference to drawings and specifications at high risk/problem moments.

The resultant impact on the labour process is that on the one hand, work is driven down, and the work of the boat builder is broken down into different jobs or processes, and on the other hand it drives work up where there is a need for a skilled boat builder who can do everything and ensure compliance to international standards. What is important to note is that these are two sides of a continuum, that are not mutually exclusive and to be able to innovate, workers must be able to reproduce.

The next step in the data analysis is to examine the South African Boat Building qualification to assess whether the South African Boat Building qualification and curriculum meet the knowledge types required to support both a Type 1 and Type 2 boat builder as outlined in this chapter.

CHAPTER 5: WHAT KNOWLEDGE IS FOUND IN THE UNIT STANDARD QUALIFICATION?

5.1 INTRODUCTION

In this chapter I firstly look at the structure of the Learnership qualification and its' entry level requirements in terms of levels, credits, subjects and a short overview of the work integrated learning component. I then undertake an analysis of the assessment criteria of the three-year qualification, utilising the four-way knowledge schema developed by Gamble (2016a). The first level of findings lead to a revised analysis schema and second level findings are presented. What emerges from the analysis is that the qualification is driven by proceduralisation and codified work practices.

5.2 ENTRY LEVEL REQUIREMENTS

The entry level requirements for the qualification as stipulated in the SAQA qualification only refer to competence in communication and mathematical literacy at NQF Level 2, equivalent of Grade 9. The TVET college, as the training provider, initially specified a minimum entrance requirement of Grade 9 as well as a literacy and numeracy test in 2006. Over time, the entry requirements were increased incrementally in response to the feedback from industry that the learners were not sufficiently prepared for the world of work during their tenure at the college. Three years later a Grade 12 entrance requirement was stipulated citing the demanding nature of the course. (Boat Building Academy Prospectus 2009). From 2009, two personal references from school and/or an employer were added to the requirements. In addition, a hand-written motivation "Why I want to be a boat builder", an individual interview and a practical woodworking task were added to the entry requirements. This change indicates both an increase in the requirements for a stronger principled knowledge base as well as a stronger emphasis on the attitude and commitment of the individual learner. If, the qualification and the curriculum both fall short of a strong principled knowledge base, it is logical that the response from industry is to ask for a stronger scientific and mathematical base, that is assumed to be present in a learner who has completed Grade 12 with both Maths and Science.

5.3 WHAT DOES THE BOAT BUILDING QUALIFICATION LOOK LIKE?

The Boat Building qualification is registered as a Learnership at levels 2, 3 and 4 on the NQF and culminates in a certificate qualification. The qualification is split between theoretical and workshop-based training during the first five months at a TVET college, followed by five months work placement in industry. This is repeated over the three years of the qualification. The training is CBMT based and a Portfolio of Evidence is required for each learner, with learners being assessed and deemed "Competent" or "Not Yet Competent" against each unit standard.

National Certificate: Yacht and Boat Building (SAQA ID 77003) 136 credits. NQF Level 2
National Certificate: Yacht and Boat Building (SAQA ID 78863) 136 credits. NQF Level 3
National Certificate: Yacht and Boat Building (SAQA ID 78864) 146 credits. NQF Level 4

Table 5: National Certificate Yacht and Boat Building

(Appendix 2: Full copy of National Certificate Yacht and Boat Building qualification)

NQF Level 2	Entry Requirement: Grade 9 (preference given to applicants with Grade 12)	
5 months Theoretical and Workshop training at the College	Portfolio of Evidence based CBMT assessment	
5 months work placement in industry	Logbook task sign off by industry supervisor	Exit to Labour Market
NQF Level 3	Entry Requirement: Deemed competent at Level 2 and moderated by Merseta	
5 months Theoretical and Workshop training at the College	Portfolio of Evidence based CBMT assessment	
5 months work placement in industry	Logbook task sign off by industry supervisor	Exit to Labour Market
NQF Level 4	Entry Requirement: Deemed competent at Level 3 and moderated by Merseta	
5 months Theoretical and Workshop training at the College	Portfolio of Evidence based CBMT assessment	
5 months work placement in industry	Logbook task sign off by industry supervisor	Exit to Labour Market

Table 6: Structure of the Boat Building Learnership

The qualification comprises a total of 418 credits broken down into fundamental unit standards, core unit standards and elective unit standards.

Fundamental (Compulsory)	Unit standards in Language and Mathematical	Level 2: 36 credits Level 3: 36 credits Level 4: 56 credits	128 credits
Core (Compulsory)	The Core component covers competencies directly related to boat building practices, health, safety and environmental issues, tools and equipment, manufacturing processes and materials.	Level 2: 90 credits Level 3: 85 credits Level 4: 75 credits	250 credits
Electives	Unit standards that are generic or specialist.	Level 2: 36 credits from which learners select a minimum of 10 credits Level 3: 31 credits from which learners select a minimum of 15 credits Level 4: 40 credits from which learners select a minimum of 15 credits	40 credits
TOTAL			418 credits

Table 7: A breakdown of the unit standard allocation for the Yacht and Boat Building Learnership

For the purposes of this study, the fundamentals of language and mathematics are not analysed as they are generic subjects required by all TVET learners registered on a learnership and, as such, do not add value to the analysis which seeks to verify whether the qualification can meet the knowledge requirements of the work place.

An interesting feature of the boat building qualification is the subjects. At face value the subjects appear to be a bundle of other trades such as electrical, welding, design, painting and joinery. This is supported by the findings above that a Type 2 boat builder needs to know everything about a boat from beginning to end. Hence the qualification logic of a boat building trade is that the learner must cover every aspect of boat building with a strong marine context embedded into the qualification. As a result, a learner completing, for example, marine joinery would have the requisite skills to apply joinery skills in a boat building yard but would not be considered an artisan joiner. Similarly, the subject Marine Electrical, whilst covering the basics of electricity also focuses on electricity in a "water" environment and would not mean the learner was a qualified electrician.

The core unit standards are compulsory in the qualification and learners are given the option of selecting a requisite number of credits towards elective unit standards. These elective unit standards are selected by the TVET college and not by the learner and effectively thus become an extension of the core unit standards taught. This will be examined in more detail when the enacted curriculum is analysed.

The table below shows the core and elective subjects in the qualification and the credit allocation.

	LEVEL 2				LEVEL 3				LEVEL 4		
Topic	Unit standard number	Credit allocation		Topic	Unit standard number	Credit allocation		Topic	Unit standard number	Credit allocation	
Boat Design	365146	20		Boat Design	376541	15		Boat Design	376540	15	
Marine Joinery	365159	30		Marine Joinery	376544	30		Standards	376580	20	
Composites	110289	9		Composites	376560	15		Composites	376582	20	
Composites	110281	8		Marine Systems	376542	25	Core	Marine Electrical	376581	20	Core
Corrosion	365145	10		Engines	376543	15		Fairing/Painting	376545	15	
Inflatable Boats	365143	5		Welding	10783	5	Elective	CAD	263024	15	
Health & Safety	13220	8	Core					CNC Operation	117166	10	Elective
Seamanship	123600	10									
Firefighting	12484	4									
First Aid	12483	4	Elective								
Welding	119753	8									
Sling loads	12481	4									

Table 8: Credit allocation for core and elective subjects in the qualification

The first phase of qualification analysis focuses on the types of knowledge contained in the boat building qualification.

5.4 QUALIFICATION ANALYSIS

SAQA unit standards are written in a specific way and follow a standard format. Each unit standard is given an identifying number and a title. The originator of the qualification and the quality assuring body are specified. The field and sub field are stated, and in the case of boat building this is Field 06 "Manufacturing, Engineering and Technology" with a sub field "Manufacturing and Assembly". Specificity is then given to the Unit Standard type, the NQF level and the number of credits followed by Registration status, start and end dates and a SAQA decision number. The purpose of the unit standard is then stated, followed by learning assumed to be in place, the Recognition of Prior Learning component and the unit standard range.

The unit standard is broken down into Specific Outcomes, each with an outcome range and this is followed by assessment criteria followed by unit standard accreditation and moderation options. The essential embedded knowledge follows and then seven standard "critical cross field outcomes" that focus on "identifying, working, organising, collecting, identifying, communicating, science and demonstrating". These critical cross field outcomes are generic across all SAQA qualifications. As a result, the qualifications appear as over-specified and lengthy documents that aim for transparency and common understanding, whilst in their attempts to do so, they ironically end up being difficult to read and obfuscate the original intention of the qualification.

In attempting to identify the knowledge types in the qualification, the study analysis focuses on the assessment criteria of the unit standards, as the assessment criteria are the end achievement point and as such are the most accessible point for trying to identify the type of knowledge embedded in the qualification. Gamble's (2016a) schema of four knowledge types were used to code the unit standard assessment criteria of the Yacht and Boat Building qualification/curriculum at NQF Levels 2, 3 and 4 using the following tool with expanded definitions for the qualification analysis.

Knowledge type	**Definition used for analysis of assessment criteria**	
K1: Specific procedures	K1	Pure "how to" knowledge Not written down Routine
K2: General procedures	K2	"Step by Step" knowledge Terminology associated with a standard Strong language/terminology requirement
K3: Specific principles	K3	Craft knowledge Drawings and sketches Non-routine Visualisation of parts and wholes
K4: General principles	K4	Scientific knowledge Written down Principles conveyed

Table 9: Analysis tool (adapted from Gamble, 2016a)

In the analysis of the unit standard assessment criteria, only those unit standards directly relating to boat building were coded because this study seeks to understand the mix of theoretical and practical knowledge in boat building as a vocation/trade. The following unit standards were not analysed:

NQF Level	**Type of Unit Std**	**Registered Unit Standard number**	**Unit standard title**
2	Elective	12465	Develop a learning plan and a portfolio for assessment
3	Elective	11714	Lead a team, plan, allocate and assess their work
3	Elective	11787	Perform on-to-one training on the job
3	Elective	116720	Understanding of diversity in the workplace

Table 10: A list of unit standards that were not analysed

The assessment criteria were each examined individually, and an attempt was made to code them against K1, K2, K3 and K4 definitions as outlined in the substantive definitions of Table 9. An excerpt example is given below of the difficulties encountered in allocating the four discrete knowledge types to the assessment criteria:

Learning Outcome	**Specific Outcome**	**Assessment criteria**	**Knowledge type**
Apply a range of boat design and	Demonstrate an understanding of the terminology associated	Components, hardware and specifications in boat design and construction are	**K2** This assessment criteria clearly fits a K2 general

construction principles	with boat design and construction	identified and their application explained in terms of international standards for boat building	procedural knowledge category; the terminology is associated with a standard; there is a strong language/terminology requirement
		Boat design terminology is explained with reference to international standards for boat building	
	Describe the materials and methods used in boat building and discuss their applications and limitations	Materials used in the construction of boats are identified and explained according to their range of uses and limitations	**K2/K4** These assessment criteria have a strong element of K2 general procedural knowledge with strong language/terminology requirements, however there is also an underpinning K4 scientific knowledge of how boats are constructed, the hull forms, design principles and different materials. This is written down and formally conveyed, hence an allocation of a K2/K4 knowledge type or what I term "applied science".
		The main methods used for the construction of boats are described focusing on the advantages, disadvantages and limitations of each	
	Identify and discuss hull forms	Hull forms are identified and explained according to their applications and limitations	
	Demonstrate an understanding of the features of a lines plan and the process of its development	The main features of a liens plan are explained focusing on boat design principles	
		A lines plan is drawn using standard drawing techniques	**K1/K2** Whilst this assessment criteria is a "how to" practical knowledge exercise, it is qualified by the term "standard drawing techniques" showing overlap into a K2 general procedural knowledge category where terminology is associated with a standard.
	Construct a scale model from a lines plan	An explanation is given of how to construct a scale model from a lines plan focusing on the possible errors to avoid	**K2/K4** This assessment criteria have a strong elements of K2 general procedural knowledge with strong language/terminology requirements, however there is also an underpinning K4 scientific knowledge of how boats are constructed, understanding of a lines plan and pre-emptive notion of what can go wrong.
		A half model is constructed according to a lines plan	**K2** "Step by Step" knowledge where a standard lines plan is the guiding procedural knowledge base

Table 11: An example taken from the initial analysis of the assessment criteria

The initial analysis of the assessment criteria using the knowledge types highlighted two key findings:

Firstly, craft knowledge K3 and Principled knowledge K4 do not feature in the assessed Core and Elective unit standards. This effectively means that knowledge transmission in the assessed component of the qualification has excluded all principled knowledge, yet the findings of the HSRC study (Gamble et al, 2015) indicate an increase in principled knowledge, K4, and a small increase in principled "craft" knowledge K3, being required in future in the workplace.

Secondly, the procedural knowledge types K1 and K2 dominate the assessment criteria of the Core and Elective unit standards and there is overlap between the knowledge types which allowed a further refinement of the analysis tool.

Based on this first level of findings, the schema was adapted to show the overlap and a second level of analysis was conducted of the Core and Elective unit standard at the three different levels.

Knowledge type	**Definition used for analysis of assessment criteria**	
K1: Specific procedures	K1	Pure "how to" knowledge Not written down Routine
	K1/K2	"How to" knowledge according to a specified procedure
K2: General procedures	K2	"Step by Step" knowledge Terminology associated with a standard Strong language/terminology requirement
	K2/K4	"Applied Science" Application of procedures to a purpose Context dependent
K3: Specific principles	Not evident in the Core and Elective Unit Stds	
K4: General principles	Not evident in the Core and Elective Unit Stds	

Table 12: Adapted analysis tool

Examples from the coding exercise to indicate how the knowledge types were allocated is shown below:

Assessment criteria NQF Level 2	Knowledge type
Measuring and marking equipment is used in boat building	K1
The metal plate is mounted according to specifications	K1/K2
The different types of adhesives are explained according to product specification	K2

The main features of a lines plan are explained focussing on boat design principles	K2/K4
Assessment criteria NQF Level 3	Knowledge type
A propeller is examined for damage	K1
Shapes are lofted from a lines plan according to boat building standards	K1/K2
The installation, maintenance and use of marine plumbing systems are explained with specific reference to national and international standards	K2
Resins used in boat building are explained focusing on the physical property data of composite marine products	K2/K4
Assessment criteria NQF Level 4	Knowledge type
The operation is performed safely and within the time allocation	K1
A simple marine electrical system is correctly installed with appropriate wiring which functions according to design	K1/K2
The preparation of the boat surface is explained in accordance with the coating system manufacturer's specifications	K2
Different aspects and features of small craft rig design are described and their implications for sailing performance discussed	K2/K4

Table 13: Sample of the coding to illustrate how the knowledge types were allocated

The four knowledge distinctions indicate that the qualification increasingly "leans" towards the central tenant of K2 knowledge. "How to" knowledge becomes specified by "procedural" qualifiers. For example, "The preparation of a boat surface is explained in accordance with the coating system manufacturer's specifications". This effectively becomes a K1/K2 knowledge type.

K2 procedural knowledge is driven upward somewhat by "qualifiers" that require an application of scientific principle to become K2/K4 knowledge types. For example, "The main features of a lines plan are explained focussing on boat design principles". The qualification does not define the level of scientific or principled knowledge, but it is assumed that the application to the codified work practice will determine the level of scientific application.

The findings using the amended analysis tool were aggregated and collated in Table 11 below.

	Level 2		Level 3		Level 4	
K1	25 assessment criteria of a total of 204	12%	2 assessment criteria of a total of 58	3%	1 assessment criteria of a total of 95	1%
K1/ K2	45 assessment criteria of a total of 204	22%	14 assessment criteria of a total of 58	24%	25 assessment criteria of a total of 95	26%
K2	114 assessment criteria of a total of 204	56%	32 assessment criteria of a total of 58	56%	60 assessment criteria of a total of 95	63%
K2/ K4	20 assessment criteria of a total of 2004	10%	10 assessment criteria of a total of 58	17%	10 assessment criteria of a total of 95	10%

Table 14: Aggregated analysis of unit standards in terms of knowledge type allocations

This shows the increasing proceduralisation of the intended curriculum. More than half the qualification is focused on codified work practice with approximately a quarter of the qualification being practically focused with "procedural qualifiers". Pure practical "how to" knowledge is evident in the first year (12.2%), the second year (3.4%) and the third year (1%) of the qualification, supporting the notion of progression with tool and hand skills as step one in a vocational qualification, decreasing dramatically in the following two years.

The applied science knowledge contributes on average about 10% to the curriculum. This applied science component only appears consistently in the topics "Boat Design" and "Composites" which are the only topics offered at each level of the qualification, supporting a notion of principled progression which is not evident in the other topics which appear as discrete "stand alone" topics in the qualification.

5.5 CONCLUSION

The analysis shows that the Yacht and Boat Building qualification prepares learners for reproductive work in terms of standardised operations. It does not prepare learners for innovation or problem solving where the end result is not pre-determined. The workplace analysis of Chapter 4 illustrated that all four types of knowledge are required in the work of a type 2 skilled boat builder but the qualification is dominated by K1 and K2 type knowledge. This combination of K1 and K2 procedural knowledge is largely evident in semi-skilled work as identified in Chapter 4. However, in the qualification, the dominant procedural assessment criteria are elevated somewhat by the high level of language and technical understanding of scientific and boat building specific terminology. This shows that an emerging requirement of systems knowledge is for learners to be able to 'talk' about boat building.

The findings show that the Boat Building qualification largely prepares learners for "re-productive" work and not "innovative work". Craft knowledge also does not present in the qualification. However, understanding unit standard criteria as representative of curriculum locates the analysis strongly within a National Qualifications Framework discourse that seeks to promote "learning outcomes" and "competence" at the expense of knowledge.

It therefore becomes necessary in the next chapter to challenge the assumption of different knowledge types by focusing on the enacted curriculum and moving beyond an outcomes-based analysis, by focusing on the re-contextualising logic of the curriculum.

CHAPTER 6: THE ENACTED CURRICULUM

6.1 INTRODUCTION

This chapter turns to the enacted boat building curriculum with a focus on the learning material and the workshop pedagogy. In both the learning material and the workshop, the apprenticeship craft logic appears. In the learning material this is observed in the cyclical presentation of topics illustrating a progressive spiral design where topics recur at different levels with increasing complexity. In the workshop, the craft logic is observed where learners use modelling and an understanding of part/whole relationships in the construction of actual products, where judgement, care and dexterity become markers of good work.

6.2 LEARNING MATERIAL

The learning material for the Yacht and Boat Building qualification was developed by the merSETA, using an independent consulting firm. There was close involvement with the industry in the learning material development process and the consultant visited boat yards and undertook a number of practical tasks in the process of writing the learning material.

At a first reading of the learning material, the units are very closely linked to the Specific Outcomes, Essential Embedded Knowledge and Critical cross field outcomes as outlined below:

Module outline and unit standard match:

Unit	Specific outcomes	Essential embedded knowledge	Critical cross-field outcomes
Unit 1:Classification of boats and hulls	**SO1 and SO3**	**EEK 1; EEK 3 and EEK6**	**CCFO1 and CCFO7**
Unit 2:Materials and methods for building	**SO1 and SO2**	**EEK1; EEK2 andEEK5**	**CCFO1; CCFO3 and CCFO5–CCFO7**
Unit 3:Basic boat design	**SO1; SO4 and SO5**	**EEK1; EEK4 and EEK7–14**	**CCFO1–CCFO6**

Figure 11: Boat Design Level 2: Excerpt from the Learner Guide

The learning material locates itself very purposefully in the qualification framework and the CBMT format, however, on closer examination of the learning material, it starts to distance itself from the strong procedural and routine language of the qualification. Subjects appear cyclically throughout the three levels of the qualification.

The “Boat Design” topic learning material was analysed in terms of the learning units, the learning activities, formative assessments and summative assessments (Appendix 4) and a few key findings are made. “Boat Design” was selected on the basis of it’s appearing at all three levels of the qualification and because of the importance of the design, materials and manufacturing interface referred to in Chapter 1.

At level 2, the learning material is largely self-directed with occasional reference to a workplace facilitator, however at level 3 the activities must all be done under the guidance of the workplace facilitator. This effectively starts moving the curriculum out of the learning space and into the workplace with increasing reference to actual tasks taking place in the boat yard. In reality, the learning material is not used in this way and is only used at the college by the facilitators and learners, and the log book is the only document that accompanies a learner when they undertake work placement.

At the same time the learning material also shows an increase in practical tasks at each consecutive level and progression is also seen in the formative assessments. For example, at level 2 the learner must “identify” “name” and “read and interpret”. At level 3 the learner must “interpret” “loft” “complete calculations” “apply a rule” “know” and “classify”. At level 4 the learner must “calculate” “find displacement weights” and “apply ISO standards”. This suggests that progression in the curriculum is in fact driven by applied science and not necessarily knowledge progression driven by increasing complexity of language.

The learning activities in the learning material demonstrate a cyclical or spiral pattern in terms of the content. At level 2 learners undertake an activity entitled “How do boats float?”, at level 3 the concept of buoyancy and displacement are explicated and accompanied by calculations. At level 4 there is a revision of buoyancy and displacement and then it is applied to displacement weight and determining areas of the water plane. Whilst Boat Building Standards are a standalone unit standard at Level 4, Standards actually first appear in Boat Design at level 2 within the context of materials and methods for building boats. The construction of a half hull model at level 2 contains principles of construction that then take place at a larger scale in level 3 when the learner must loft from a lines plan. This demonstrates that work, tasks and terminology are largely cyclical in the curriculum. Things do not get finished and come back at different levels throughout the qualification.

Another key finding is the strong emphasis on terminology with 47 words in the glossary at level 2, 43 words in the glossary at level 3 and 40 words in the glossary at level 4. There is repetition of words in the glossary at each level supporting the cyclical pattern of knowledge acquisition referred to above. Learners return to concepts each year with increments of complexity emerging in the inclusion of new terminologies, as well as the revision of concepts each year.

The cyclical aspect of the curriculum is further demonstrated in examining the learning material for Inflatables at level 2. When looking at the qualification itself and the specific outcomes and assessment criteria, it would appear that Inflatable Boats is a standalone unit standard with very little relevance to other subjects such as Boat Design and Composites which reappear at each level of the qualification. However, an analysis of the Inflatable learning material shows that it covers: stability, buoyancy, performance, ISO standards compliance, health and safety, teamwork, construction processes, materials, adhesives, tools, production processes, measuring, cutting, grinding, hull parts and job cards. These concepts and tasks re-occur throughout the learning material in a spiral fashion with increasing complexity. Therefore, the study surmises that in fact this curriculum does in fact have an element of craft or K3 knowledge present which was not evident in the analysis of the qualification which only appeared to transmit K1 and K2 knowledge combinations.

6.3 WORKSHOP ACTIVITIES

The following practical workshop tasks are undertaken by the learners over the three years.

Level 2	Produce a small table (design differs from year to year)
	Produce a fibreglass clock from an existing mould
Level 3	Produce a tool box using 4 different types of joints
	Loft the strong back of a small boat
Level 4	Infuse model boat, keel and rudder
	Work on various aspects of a small sailing boat "The Cat Boat" including lay-up, demoulding, finishing, wooden mast making, teak decking and caulking, finishing and fitting out rig, building a trailer (This boat has been under construction for 5 years and each year, learners undertake the tasks required at different stages of the building process)

The selection of workshop tasks at the three levels, start to clearly diverge from the assessment criteria specified in the qualification in chapter 5. For example, the marine joinery unit standard at level 2 contains just two K1 assessment criteria and three K1/K2 assessment criteria.

- Measuring and marking equipment is used in boat building (K1)
- Basic hand and power tools are used safely in accordance with standard procedure (K1)
- Woodworking joints are accurately marked out according to specification (K1/K2)
- Joints are made according to specification (K1/K2)
- Joints are fitted according to the adhesive specification (K1/K2)

These assessment criteria are then applied to the practical task of producing a small table. Clearly, there is more than just measuring, marking, the use of power tools and the making and gluing of joints in the production of a small table. Whilst the CBMT logic divides the curriculum into modular and sequential tasks, the practical manifestation of the task is something completely different and requires an apprentice craft logic that rests upon tacit knowledge and the ability to see the 'parts' and 'wholes" and to make a table from a drawing.

As Gamble finds in her study of joinery apprentices, the master-trainers are not subverting the formal curriculum intentionally in their selection and assessment of learners producing a small table, they are simply passing on their craft in the only way they can (2004: 156). In a trade workshop, learners will always be working on a project that is not restricted to sequential qualification assessment criteria statements and goes beyond the procedural qualification specifications as discussed in Chapter 5.

The Learner Guide for Marine Joinery outlines specific and procedural practical formative assessment tasks that include creating panels for a box, making a wooden frame, applying glue to a frame and creating a butt joint. However, the Learner Guide has no direct part in the workshop instruction of the Marine Joinery component which has always involved the production of a small table of differing design. It is not that the tasks per se in the Learner Guide are not relevant and valuable to the learning process, but they are couched in the K1/K2 procedural language of the qualification. The workshop component of the boat building qualification by virtue of the choice of projects is more than K1/K2 knowledge and by choosing the production of a particular item, a small table, the workshop component starts to locate itself in a craft logic with an underpinning K3 tacit knowledge. The evaluation of the learner is not against specific criteria, but in the completion of the table according to the drawing design, under the supervision of the lecturer. As Gamble found the acquisition of a tacit knowledge base is simply not possible through a highly specified and procedural curriculum mode (2004:156) and the boat building workshop tasks demonstrate a similar divergence from the specified CMBT qualification format.

This selection of workshop tasks substantiates Gamble's findings that craft is a form of principled knowledge, but it is visualised and not written down. It is a specialised expertise that is not procedural and is transmitted through a strong pedagogy where the part is taught in the presence of the whole and there is strict progression in terms of difficulty.

However, what is interesting in boat building, is that it is more than one trade. Whilst joinery is a strong component of the workshop tasks, with an increasing complexity of tasks, from producing a table, to producing a tool box, to laying teak decking over the three years of the qualification, the other workshop tasks require different competencies.

At level 2, learners produce a fibreglass clock using hand lay-up techniques. At face value, the production of a clock in a boat building workshop appears anomalous, however, the mould of the clock face is in the shape of an old-fashioned ships wheel and has curved edges. The prevailing logic, is that boat hulls are also curved and that learners need to know how to lay up curved surfaces according to a standard. At level 4, learners take on the more complex project of vacuum infusing a model boat including the keel and rudder, using different materials and processes. Neither of these projects are what a learner will do in a workplace but are a simulation of hand skills needed for the boat building process.

The lofting of a strong back in level 3 workshop time is where the design and manufacture interface in boat building is most obviously observed. Learners take a drawing and translate that into the actual size and shape of the boat by producing the stations or "skeleton" of the boat. This is the very first process in boat building and it is an old and well-established procedure.

However, in modern day boat building, lofting is now done by CNC (Computer Numerical Control) machines and the boat builder no longer painstakingly marks out the boat station shapes on a lofting floor. A conceptual understanding of the process of lofting in a modern-day boat building yard is needed, but more importantly in a modern boat building context, knowledge of the CNC software and the "milling bed" of the machine and how to align materials and machine are needed. Whilst a CNC machining unit standard is offered as an elective at level 4 in the qualification, as mentioned earlier, this is not offered by the college due to limitations with maintenance and operation of the machine. This resource limitation takes the boat building qualification a step further away from meeting the requirements of a modern-day boat building yard driven by innovation.

The workshop activities at level 4, other than the infusion of a model boat, become further dislocated from the qualification, showing almost no direct relation to the assessment criteria at level 4. The primary activity over the last five years, has been the construction and fit out of a small sailing boat called the "Cat Boat".

It is here that the multiple trade aspect of boat building is demonstrated in practice. Not to be exhaustive in describing the process of building a "Cat Boat", but as a means of demonstration, these are just some of the activities and processes undertaken by learners over the course of five years in constructing the boat. Learner activities may include lofting the boat, constructing the strong back, planking the hull, fairing the hull, building a supporting frame, constructing a deck, fitting and bonding the deck, installing seating, installing buoyancy, making a wooden mast, stepping the mast, laying the floor boards and reinforcing, laying a teak deck and caulking, fitting all the running rigging components, sanding, finishing, varnishing, and building a trailer. Whilst sequential in terms of build processes, the construction activities are a synthesis of different parts into a whole visualisation of a finished "Cat Boat".

Whilst recognising the craft component of boat building, in a modern context, boat building, unlike cabinet making, train driving and other trades, is not one trade, but a combination of trades. As stated in the rules of the qualification:

> "Yacht and Boat Building, can be differentiated from most other trades by the extremely wide range of core competencies that are required by the technically competent practitioner. A high level of skill and understanding are necessary in activities as diverse as joinery, metalwork, fibreglass fabrication, and electrical, mechanical and plumbing installation for the professional boatbuilder."

Importantly, in the qualification rule statement, it is both *skill and understanding* (my emphasis) that are needed in the different trade areas.

During workshop observation, learners are all engaged in discrete and separate activities which appear largely self-directed. Learners periodically consult the lecturer, who himself is busy with a task. The lecturer, in one instance, in turn consults with the other lecturer who moves in and out of the workshop space. Consensus is reached by the lecturers on what the next step is, and this is then conveyed to the learner. The lecturer has an overview of the workshop space but rarely intervenes with the learners unless asked, or unless safety issues arise.

Workshop Observation E: 22 March 2012
Learner A: Planing a block of wood
Learner B: Pulling masking tape from the keel of the "Cat Boat"
Learner C: Sanding a table leg
Learner B: Tidies the work bench, walks over to chess board table to feel spray finish
Learner C: Finishes sanding, puts table on its end and checks alignment. Also moves over to feel the spray finish with Learner B. Both discuss and closely examine and then Learner C continues sanding

As Gamble (2004) found in her study of cabinet making there is very weak framing in the workshop component of the boat building course and transmission takes place through modelling rather than explicit teaching. This component of the course clearly demonstrates a strong craft or K3 knowledge base that is context bound in both transmission and realisation, with the lecturers controlling the pedagogic discourse of transmission and regulating the content in terms of deciding the practical project component.

Coherence is created through the construction processes and crucially the privileged repertoire of the lecturers drives the modelling process, whereby learners internalise the judgement, care and dexterity that is seen as characteristic of good workmanship.

6.4 CONCLUSION

The analysis of the enacted curriculum surfaces interesting aspects of the boat building curriculum that are not apparent in the chapter 5 analysis of the qualification. The qualification addresses specific procedural and general procedural knowledge however the learning material demonstrates some progression and a cyclical content base that returns, at various points in the curriculum, at a higher level suggesting the emergence of craft knowledge. This is not an explicit curriculum decision, but something that emerges in the delivery of the programme supporting the notion of the tacit; that which is hard to describe. In the workshop activities this finding is substantiated with the activities following a strong craft and apprenticeship-based modality. However, in the enacted curriculum, as in the qualification, what is missing is the explicit scientific principled knowledge and the aquatic/water context specificity. These findings will be discussed more fully in the next chapter.

CHAPTER 7: THE IMPLICATIONS FOR THE DUAL DEMANDS OF INNOVATION AND REPRODUCTION IN BOAT BUILDING

7.1 INTRODUCTION

The purpose of this research study was to investigate the mix of situated and formal knowledge in a South African boat building qualification, more particularly, the study sought to answer the question:

"To what extent does the South African Boat Building qualification meet the dual demands of both innovation and reproduction by industry?"

This required setting up a conceptual knowledge framework based on Gamble's four-way knowledge schema (2016a) where principled and procedural knowledge and formal and situated knowledge provide a useful lens for the examination of a relatively newly introduced vocational qualification in boat building. Because the study sought to understand the educational provision, as well as the requirements of industry labour processes, a second conceptual framework drawn from work itself was used. The complimentary but dialectically opposed labour process distinction of innovation and 'flexible specialisation" and reproduction and routinisation were used for the framework and linkages were made to the educational knowledge construct. This oppositional and complementary demand for innovation and reproduction in boat building is of interest in a trade which has deep historical roots and a long history of apprenticeship whilst at the same time being a trade located in a modern context strongly driven by technological innovations and global competitiveness.

With this established framework the study turned to boat building practices and occupational variations. Extending the work of an HSRC study (Gamble et al, 2015) done into artisanal work of the future in which I participated as a researcher for the boat building component. My study extended the empirical base and found two complementary work processes of skilled and semi-skilled work found in small and large/medium firms, respectively. In the empirical analysis, defined by firm size, the study found different knowledge bases underpinning the two occupational variations and this finding answers the first sub question of the thesis; *What combinations of knowledge are required in boat building practices?*

The study then turned to the qualification to answer the second sub question; *What knowledge is contained in the boat building qualification?* An in-depth analysis of the qualification using an adapted version of Gamble's four-way knowledge schema was applied to reach the findings. This part of the study was extended to analyse the college workshop activities and the learning material used at the college, to ascertain if there were other knowledge types present in the enacted curriculum.

The last sub question of the thesis was *What is the relationship between knowledge and different types of labour processes in boat building?* This difficult juxtaposition of work and knowledge was a challenge in the study and it was only by holding up the HSRC knowledge findings against the work observation data, that distinctions could be drawn between large/medium and small firms and semi-skilled work and skilled work. This finding will be unpacked further in the discussion below.

7.2 DISCUSSION OF THE FINDINGS

Using the sub-fractal lens developed in Chapter 4, the study sought to ascertain if the qualification and curriculum for boat building in South Africa could meet the innovation and reproduction demands. On the one hand routine SOP driven work and practice driven innovation are underpinned by K1 and K3 knowledge and ISO driven work and knowledge driven innovation are underpinned by K2 and K4 knowledge.

What the study found is that there is no craft or principled knowledge transmitted in the unit standards-based qualification. In other words, craft knowledge and principled knowledge have been excluded from the CBMT format of the qualification, where outcomes and assessment criteria are written in sequential step by step form with tick box assessment criteria. However, upon examination of workshop practical activities the study has shown, in the re-contextualising logic of the curriculum, that craft knowledge is weakly transmitted through a craft logic in the workshop component of the course. What this shows is that only practice driven innovation is transmitted in the boat building curriculum. In other words, the curriculum only teaches innovation as craft and not as principled knowledge. Therefore, knowledge driven innovation, where research and development and technology transfer lie is not addressed at all in either the qualification or the curriculum. Similarly, the technical ISO driven work of reproduction is only addressed at a procedural level (K2 knowledge) and at a combination of K2/K4 knowledge which I have termed "Applied Science", or application of procedures to a purpose that is strongly context dependent. This omits the pure K4 principled knowledge needed for knowledge driven innovation and a high-level understanding of ISO standards. In other words, the qualification only transmits a certain level of technical language, as opposed to principled understanding. Crucially the study shows that the qualification itself only addresses the procedural and sequential requirements of boat building as seen in semi-skilled work, where work is routinized to a standard.

The boat building enacted curriculum attempts to teach in the old craft-based methodology of apprenticeship, as observed in the workshop component of the course, the selection of items to be produced and the logic of some of the learning material used. Whilst this speaks to the historical craft-based trade of boat building, as one of the oldest forms of engineering, it does not speak to the modern technological drivers that are increasingly emphasised in boat building. Against a global picture of increased technological development, digitisation, robotics and green technology developments, this places the qualification and the curriculum at a distinct disadvantage in attempting to transmit the type of knowledge that will be required for both innovation and reproduction.

The labour process work observations also cannot show any K4 principled knowledge as this is contained in the initial design of the boat which is continually referenced by the boat builder during the building of the boat. Therefore, in the labour process one does not observe principled knowledge other than its application to a purpose. This excludes knowledge driven innovation on the shop floor. It is at the interface between design, materials and work processes that the tension lies and the expectation that boat builders should in fact be able to both innovate and reproduce is a misnomer or an aspirational notion that is not practical for the majority of learners being trained to become boat builders.

7.3 INTERPRETATIONS AND CONCLUSIONS

In conclusion, to answer the question as to why the South African boat building qualification is of concern to an industry that locates itself both within a modern and historical context, the following findings have been made:

1. The CBMT format of the boat building qualification privileges the transmission of procedural knowledge and omits principled knowledge required to support knowledge driven innovation.

2. The CBMT format of the qualification, whilst being procedural, does transmit a level of technical language by virtue of the contextual notion of what I have termed “Applied Science” in Chapter 5.
3. The need to understand ISO standards in a procedural qualification, is also only partially addressed through the contextual “Applied Science” and does not support pure scientific and principled understanding.
4. The enacted curriculum in the workshop component only teaches an old craft-based method of apprenticeship which supports practice driven innovation but does not support knowledge driven innovation and technological development.
5. In the labour process analysis, the drive for reproduction is strongly supported by the procedural nature of both skilled and semi-skilled work. However, social practice driven innovation is only supported by an emerging craft knowledge observed only in semi-skilled work.

This study contributes to social realist arguments about the importance of knowledge in vocational education and theoretical knowledge and the role it plays in qualifications and curriculum. It builds on the studies by Gamble (2004) and Coetzee (2011) by focusing on another trade in South Africa. The study extends the HSRC study (2015) that finds boat building will have a stronger scientific base in future, whilst remaining committed to proceduralisation and standardisation. This study highlights the differences between large/medium and small boat building firms in terms of work process and knowledge requirements.

Firstly, by focusing on the qualification in CBMT format, the study supports critiques of the instrumentalist notion of competency-based qualification frameworks where learning outcomes are dissociated from the context. Secondly, the analysis of the curriculum supports Gamble’s findings of tacit craft knowledge and specialised expertise in cabinet making by identifying craft in the workshop component of the boat building curriculum. Thirdly the study finds that this workshop teaching supports social practice innovation, but it does not support scientific innovation. In an industry where both standardisation and innovation are a requirement, the study suggests that both the qualification and the curriculum fall short of meeting a perceived increased technical demand from an industry competing globally.

7.4 LIMITATIONS OF THE STUDY

The use of a single case study does not ensure generalisability. The study has intentionally focused on knowledge and has utilised a knowledge model or schema to examine a vocational qualification that aims to meet the dual demands of innovation and reproduction. To strengthen the claim to the generalisability of findings, the knowledge model could be applied to other vocational fields where there are dual industry demands, for example in the aviation industry. Another possible area of study is to examine how science-based innovation can be practically taught in a workshop environment and in classroom practice.

It is hoped that this study contributes in a small way to the debates about vocational knowledge and curriculum and knowledge based artisanal futures.

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APPENDIX 1: Yacht and Boat Building elective and core unit standards, specific outcomes and assessment criteria: full analysis

Level 2 Yacht and Boat building elective and core unit standards, Specific outcomes and assessment criteria

			CREDITS	SPECIFIC OUTCOME	ASSESSMENT CRITERIA	KNOWLEDGE TYPE
Core	365146	Apply a range of boat design and construction principles	20	Demonstrate an understanding of the terminology associated with boat design and construction.	Components, hardware and specifications in 'boat design and construction' are identified and their application explained in terms of international standards for boat building.	K2
					Boat design terminology is explained with reference to international standards for boat building.	K2
				Describe the materials and methods used in boat building and discuss their applications and limitations.	Materials used in the construction of boats are identified and explained according to their range of uses and limitations.	K2/K4
					The main methods used for the construction of boats are described focussing on the advantages, disadvantages and limitations of each.	K2/K4
				Identify and discuss hull forms.	Hull forms are identified and explained according to their applications and limitations.	K2/K4
				Demonstrate an understanding of the features of a lines plan and the process of its development.	The main features of a lines plan are explained focussing on boat design principles.	K2/K4
					A lines plan is drawn using standard drawing techniques.	K1/K2
				Construct a scale model from a lines plan.	An explanation is given of how to construct a scale model from a lines plan focussing on the possible errors to avoid.	K2/K4
					A half-model is constructed	K2

					according to a lines plan.	
Core	[365159]()	Demonstrate a practical understanding of marine joinery	30	Demonstrate an understanding of the properties and uses of wood, plywood and other manufactured boards used in boatbuilding.	The lumber conversion processes and the specific properties of the resultant products are demonstrated according to the specified application.	K2
					The different species of timber used in boatbuilding are explained focussing on their specific properties and applications.	K2
					Plywood manufacturing and grading processes are explained in terms of their conformity to international marine standards.	K2
					Properties of other manufactured boards, and their application in boatbuilding are explain according to boat building standards.	K2
				Demonstrate an understanding of the properties and uses of the different adhesives used in boatbuilding.	The different classes of adhesives and their specific properties are explained in relation to Boat Building standards.	K2
					The different types of adhesive are explained according to product specification.	K2
				Demonstrate an understanding of the use of the wide range of fasteners used in boatbuilding.	The different materials used in the manufacture of fasteners are explained according to their properties.	K4
					Different fasteners are explained according to their applications, size and range.	K2
				Use measuring and marking equipment in a marine environment.	The specific uses of measuring and marking equipment are explained in terms of their specific application in boatbuilding.	K2
					Measuring and marking equipment is used in boat building.	K1

				Use basic hand and power tools in boatbuilding applications.	The application of different hand and power tools is explained in terms of their use in boatbuilding.	K2
					Basic hand and power tools are used safely according to standard procedure.	K1
				Make basic woodworking joints.	Woodworking joints are accurately marked out according to specification.	K1/K2
					Joints are made according to specifications.	K1/K2
					Joints are fitted according to the adhesive specifications.	K1/K2
Core	365145	Demonstrate an understanding of corrosion and basic metalwork in a marine environment	10	Demonstrate an understanding of basic corrosion processes.	Three categories of corrosion are explained in terms of scientific process.	K2/K4
					The causes of corrosion are explained.	K2/K4
					Methods of controlling and preventing corrosion are explained in the context of a marine environment.	K2/K4
				Demonstrate an understanding of the 'galvanic series' of metals in sea water.	Factors necessary for galvanic corrosion are explained in the context of a marine environment.	K2/K4
					Factors affecting the rate of galvanic corrosion are explained in the context of a marine environment.	K2/K4
				Demonstrate an understanding of the installation of corrosion protection and prevention equipment on a boat.	Boat parts most at risk of corrosion are identified in the context of a marine environment.	K2/K4
					The corrosion risk associated with the different materials used in the manufacture of boat components is explained.	K2/K4
					Precautions and actions to be taken to minimize the risk of corrosion are explained in the context of a marine environment.	K2/K4

				Manufacture metal components.	A metal plate is marked, cut, drilled, tapped and shaped according to specifications.	K1/K2
					The metal plate is prepared and painted according to specifications.	K1/K2
					The metal plate is mounted according to specifications.	K1/K2
Core	[365143]	Demonstrate an understanding of inflatable boat technology	5	Demonstrate an understanding of rigid inflatable boats.	National and international standards relating to inflatable boats are understood and explained.	K2
					The need for locally built boats to comply with international standards is explained in terms of acceptability of South African boats internationally and increasing the size of the boatbuilding sector.	K2
					The design and construction of rigid inflatable boats is explained.	K2
				Demonstrate an understanding of the properties of materials and adhesives used in the construction of inflatable boats.	Materials are explained with reference to their application in inflatable boat construction.	K2
					Adhesives are explained with reference to their application in inflatable boat construction.	K2
				Demonstrate an understanding of materials and adhesives used in inflatable boat construction.	The advantages and disadvantages of different materials are explained according to their ability to meet inflatable boatbuilding specifications.	K2/K4
					The advantages and disadvantages of different adhesives are explained according to their ability to meet inflatable boatbuilding specifications.	K2/K4
				Demonstrate the methods of joining rigid and inflatable parts.	The advantages and disadvantages of methods of connecting rigid and inflatable parts are explained according	K2/K4

					to their ability to meet inflatable boatbuilding specifications.	
					Rigid and inflatable parts are joined using the different methods available.	K2/K4
Core	110281	Fabricate a polymer composite product	9	Apply surface coating.	Refer to consolidated assessment criteria in specific outcome 4.	
				Apply body of resin and reinforcement materials, and consolidate into a laminate.	**Results achieved**	
				Apply surface coatings to back of laminates.	· A fabricated composite product is produced	
				Prepare edges, align components and apply resin and reinforcements to join composite parts.	**Indicators**	
					· Fabricated product meets standards	K2
					· Fabricated product can be consistently fabricated within the time standards	K2
					· Resins and reinforcements are applied according to specifications	K2
					· Ratio of resin and reinforcement is uniform across the whole fabrication	K2
					· Products are properly cured	K1
					· Work is performed with due regard to the safety and health of self, fellow workers and the environment in general and appropriate safety equipment is used	K2
					· Working area is kept neat and cleaned after use	K1
					· Tools and equipment are cared for, cleaned and stored according to manufacturing standards	K1/K2
					· Correct tools are identified	K1
					Respond to "what if" and "why" questions covering:	
					Waste and waste levels	K2/K4

					⍰ Processing of materials	K2/K4
					⍰ The curing process	K2/K4
					⍰ The incorrect use of surface coatings	K2/K4
					⍰ Build sequence	K2/K4
					⍰ Behaviour of materials	K2/K4
Core	110289	Identify and work with material as required for polymer composite fabrication	8	Identify and discuss the role and properties of materials used in the manufacturing of.	1. The assessment criteria have been formulated in this way to provide guidance to assessors:	
					Indicators	
					1. Materials are correctly identified	K2
					2. Quantities are measured correctly	K1/K2
					3. Materials are correctly mixed	K1/K2
					4. Mixing and transport procedures are applied consistently	K1/K2
					5. Work is performed with due regard to the safety and health of self, fellow workers and the environment in general	K1/K2
					6. Materials are handled according to standards	K1/K2
					7. Data is recorded accurately	K2
					Respond to "what if" and "why" questions covering:	
					1. Physical properties of the materials	K2/K4
					2. How materials react	K2/K4
					3. How the environment affects them	K2/K4
					4. Consequences of incorrect mixing and handling	K2/K4
					5. The need for accurate records	K2/K4
				Determine ratio, measure and mix materials for composite production in contact moulding.	As above	
				Transport and store materials.	As above	
				Report problems, discuss issues and record data.	As above	
Core	13220	Keep the work area safe and productive	8	Discuss and explain the purpose of safety equipment and procedures	1. An understanding of safety issues at work is demonstrated.	K2
					2. All work is undertaken in a safe	K1/K2

	manner according to established procedures.	
	3. Work area is in a neat and tidy condition.	K1
	4. Reports on safety issues are made as required.	K2
Identify and explain the purpose of demarcated areas, emergency stops, exits and first aid stations	1. An understanding of safety issues at work is demonstrated.	K2
	2. All work is undertaken in a safe manner according to established procedures.	K1/K2
	3. Work area is in a neat and tidy condition.	K1
	4. Reports on safety issues are made as required.	K2
Use personal protective equipment	1. An understanding of safety issues at work is demonstrated.	K2
	2. All work is undertaken in a safe manner according to established procedures.	K1/K2
	3. Work area is in a neat and tidy condition.	K1
	4. Reports on safety issues are made as required.	K2
Perform housekeeping duties in work area	1. An understanding of safety issues at work is demonstrated.	K2
	2. All work is undertaken in a safe manner according to established procedures.	K1/K2
	3. Work area is in a neat and tidy condition.	K1
	4. Reports on safety issues are made as required.	K2
Identify and respond to unsafe or potentially unsafe conditions, incidents or acts that may occur	1. An understanding of safety issues at work is demonstrated.	K2
	2. All work is undertaken in a safe manner according to established procedures.	K1/K2
	3. Work area is in a neat and tidy condition.	K1
	4. Reports on safety issues are made as required.	K2

Elective	123600	Demonstrate seamanship for the safe crewing of a small craft	10	Identify the types of ropes and demonstrate the practical application of ropework.	The different types of ropes are visually identified by explaining their materials and characteristics.	K2
					The different types of knots are demonstrated in relation to their applicability and intended purpose.	K1/K2
					The different types of splicing are demonstrated in relation to its applicability and its intended purpose.	K1/K2
					The different types of whipping and finishing are demonstrated in relation to their applicability and its intended purpose.	K1/K2
					The operation of lifting apparatus is explained in terms of its usage for sail handling, deck operations, boat handling and safe seamanship.	K1/K2
				Identify and explain different types of working decks and the uses of working deck fittings.	The cockpit layout and design is explained in relation to steering systems on board.	K2
					Masts, spars and rigging are explained in relation to specific components and equipment.	K2
					Different anchors and equipment are identified to reflect their uses in a variety of conditions.	K2
					Specific sail handling equipment is identified and explained relative to their function.	K2
					General deck equipment is identified and explained relative to its function.	K2
					General deck electrics are identified and explained relative to its function.	K2
					The positioning and installation of gas lockers are described and explained in	K2

	accordance with legal prescripts.	
Identify and explain different types of small craft interiors and equipment.	The general interior accommodation is identified and explained in relation to specific design purposes.	K2
	Heating and ventilation equipment are explained and discussed in relation to practicability for use at sea.	K2
	General interior plumbing and water tanks are identified and explained to reflect their safe use.	K2
	The equipment used for interior lighting is explained and discussed relative to natural and artificial lighting requirements at sea.	K2
	The design of bilges are described to reflect their purpose in the safe operation of small craft.	K2
Identify and understand safety equipment and legislation for safe boating practices.	The location of safety equipment is identified and its uses are explained for safe boating practices in accordance with relevant legislation.	K2
	The location of fire fighting equipment is identified and its uses are explained in accordance with relevant legislation.	K2
	The procedures for recovering a person overboard are explained and discussed in relation to prevailing weather conditions.	K2
	An understanding is demonstrated of various accidents and illnesses at sea by describing the unique procedures to be followed for recovery.	K2
Understand and demonstrate practical boat handling skills.	Sailing regulations are understood and basic seamanship is demonstrated	K1/K2

					relative to practical boat handling.	
					The small craft is prepared and rigged for operational requirements.	K2
					The small craft is launched in accordance with casting off and departure practices relative to area of operation.	K2
					The craft is manoeuvred and operated safely in accordance with the type of small craft.	K2
Elective	12465	Develop a learning plan and a portfolio for assessment	6	**THIS UNIT STANDARD WAS OMITTED AS IT DOES NOT RELATE TO CORE BOAT BUILDING COMPETENCIES**		
Elective	12484	Perform basic fire fighting	4	Discuss and explain procedures for dealing with fires in the workplace	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the appropriate personnel.	K2
					4. Reports on status of fire and equipment are completed.	K2
				Identify the type of fire, its context and select the appropriate fire fighting procedure	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the appropriate personnel.	K2
					4. Reports on status of fire and equipment are completed.	K2
				Identify, select and check appropriate fire fighting and safety equipment	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the	K2

					appropriate personnel.	
					4. Reports on status of fire and equipment are completed.	K2
				Fight containable/extinguishable fires	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the appropriate personnel.	K2
					4. Reports on status of fire and equipment are completed.	K2
				Retreat from fire site and hand over to appropriate personnel	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the appropriate personnel.	K2
					4. Reports on status of fire and equipment are completed.	K2
				Report/record status of fire and equipment	1. An understanding of procedures for dealing with fires in the workplace is demonstrated.	K2
					2. Fires are contained and/or extinguished.	K1
					3. The fire and/or the site are handed over to the appropriate personnel.	K2
					4. Reports on status of fire and equipment are completed.	K2
Elective	12483	Perform basic first aid	4	Explain and discuss basic first aid concepts	1. An understanding of basic first aid concepts is demonstrated.	K2
					2. Basic first aid is applied in the case of an injury at work or a medical emergency.	K1
					3. Injured/ill persons are handed over to appropriate personnel.	K2

					4. Basic first aid reports are completed.	K2
				Determine the nature of the injury/medical emergency, the context of the injury and basic first aid	1. An understanding of basic first aid concepts is demonstrated.	K2
					2. Basic first aid is applied in the case of an injury at work or a medical emergency.	K1
					3. Injured/ill persons are handed over to appropriate personnel.	K2
					4. Basic first aid reports are completed.	K2
				Hand over the injured/ill person to medical personnel	1. An understanding of basic first aid concepts is demonstrated.	K2
					2. Basic first aid is applied in the case of an injury at work or a medical emergency.	K1
					3. Injured/ill persons are handed over to appropriate personnel.	K2
					4. Basic first aid reports are completed.	K2
				Complete first aid report	1. An understanding of basic first aid concepts is demonstrated.	K2
					2. Basic first aid is applied in the case of an injury at work or a medical emergency.	K1
					3. Injured/ill persons are handed over to appropriate personnel.	K2
					4. Basic first aid reports are completed.	K2
Elective	119753	Perform basic welding/joining of metals	8	Prepare for work activity.	Job instructions are read to determine sequence of operations.	K2
					Required heat related welding/joining equipment and consumables are selected.	K1/K2
					Pre-operational checks on equipment are carried out correctly.	K1/K2
					Unsafe or worn parts or defective equipment or potential hazards	K2

					are reported in the required format.	
					Materials are prepared for welding/joining.	K2
					Special personal protective equipment is used during the operation.	K2
				Weld/join metals.	Work area is prepared for welding/joining process.	K2
					Work area is secured.	K2
					Appropriate weld/join process is used.	K2
					The metal is welded/ joined correctly to give a good quality finish.	K1
				Apply quality checks on completed weld/joint.	Weld/join is cleaned correctly.	K1
					Visual checks for quality finishes are conducted at the end of the process.	K1/K2
				Perform finishing activities.	Scrap material is disposed of according to organisational procedure.	K2
					Surplus materials are stored according to organisational procedure.	K2
					Equipment is cleaned and stored according to organisational procedure.	K2
				Report out of compliance or unsafe conditions while working.	Problems with materials and equipment are reported.	K2
				Work safely with due care for self, fellow workers, equipment, materials and the environment.	Materials and work area are prepared.	K2
					Sufficient safety materials are continuously available.	K2
					Work area is restored to a safe and serviceable condition after activity.	K2
Elective	12481	Sling loads	4	Plan and prepare for load slinging activity.	1. Load weight and slinging methodology is determined.	K1/K2
					2. Loads are safely slung.	K1/K2

	3. Documents and reports are completed.	K2
	4. Read and interpret task instruction and worksite procedure	K2
	5. Determine the weight of the load and the appropriate slinging methodology accurately.	K1/K2
Prepare site and equipment for load slinging.	1. Load weight and slinging methodology is determined.	K1/K2
	2. Clear site of personnel.	K1
	3. Documents and reports are completed.	K2
	4. Identify and select equipment against the load to be moved.	K2
	5. Conduct pre-use checks on all equipment to be used.	K2
Sling load.	1. Attach slinging equipment to loads with or without lifting lugs.	K1
	2. Loads are safely slung.	K1/K2
	3. Documents and reports are completed.	K2
	4. Balance the load and check working clearances timeously and safely.	K1/K2
	35 Signal the lifting equipment operator.	K1
	6. Conduct post-slinging activities.	K2
Signal the lifting equipment operator.	1. Load weight and slinging methodology is determined.	K1/K2
	2. Loads are safely slung.	K1/K2
	3. Documents and reports are completed.	K2
Conduct post-slinging activities.	1. Load weight and slinging methodology is determined.	K1/K2
	2. Loads are safely slung.	K1/K2
	3. Documents and reports are completed.	K2
Care for and store load slinging equipment	1. Ensure equipment is not damaged.	K1

	2. Loads are safely slung.	K1/K2
	3. Documents and reports are completed.	K2
	4. Problems are timeously communicated to the appropriate role players.	K2
	5. Correct storage techniques are adhered to.	K2
Report on slinging equipment condition.	1. Equipment operational inspections conform to manufacturer specifications.	K2
	2. Loads are safely slung.	K1/K2
	3. Documents and reports are completed.	K2
	4. Documents and reports regarding operations and inspections are clear, accurate and complete.	K2
	5. Completion of load moving is reported to appropriate personnel.	K2
	6. Work safely with due care for self, fellow workers, equipment, materials and the environment.	K1/K2
	7. Incidents and problems related to load slinging.	K2
Discuss and explain incidents and problems related to load slinging.	1. Load weight and slinging methodology is determined.	K1/K2
	2. Loads are safely slung.	K2
	3. Documents and reports are completed.	K2
Work safely with due care for self, fellow workers, equipment, materials and the environment.	1. Load weight and slinging methodology is determined.	K1/K2
	2. Loads are safely slung.	K2
	3. Documents and reports are completed.	K2

Level 3 Yacht and Boat building elective and core unit standards, Specific outcomes and assessment criteria

CREDITS	SPECIFIC OUTCOME	ASSESSMENT CRITERIA	KNOWLEDGE TYPE

Core	376541	Apply a range of boat design and construction techniques	15	Demonstrate a practical understanding of boat design.	The design of yachts and boats is identified and explained according to main features and principles.	K2/K4
					The lines plan features are identified and their inter-relationships explained according to specifications.	K2/K4
				Demonstrate an understanding of the process of lofting shapes from a lines plan.	The process of lofting from a lines plan is explained according to boat building standards.	K2/K4
					Shapes are lofted from a lines plan according to boat building standards.	K1/K2
				Calculate areas and volumes in boat design.	The importance of calculating areas and volumes in boat design is explained.	K2/K4
					Areas and volumes are calculated using formulae and given design specifications.	K2/K4
				Explain the rudder design in yachts and boats.	The main features, requirements and considerations for rudder design are explained according to design principles.	K2/K4
Core	376560	Construct and repair composite marine components	15	Demonstrate an understanding of composites in a marine environment.	Resins used in boatbuilding are explained focusing on the physical property data of composite marine materials.	K2/k4
					The combination of reinforcement materials and resin systems are explained according to a variety of structural laminates.	K2/K4
					The advantages and disadvantages of different core materials are explained according to their physical properties.	K2/K4
				Apply resin, fabric and core materials in both a new construction and repair situation.	Core materials are identified for various boat building applications.	K2
					Optimal strength to weight ratio is explained according to composite construction.	K2/K4
					Composite components are constructed and repaired according to structural composite procedures.	K1/K2

				Demonstrate an understanding of composite boat structures.	The advantages and disadvantages of Solid laminate construction in terms of established practices.	K2
					The advantages and disadvantages of Solid laminate with stringer construction are explained according to established practices.	K2
					The advantages and disadvantages of Cored laminate/sandwich construction are explained according to established practices.	K2
Core	376542	Install and maintain a range of marine systems	25	Demonstrate an understanding of an on-board fuel system.	The components of an on-board fuel system are identified and explained according to boat building standards.	K2
				Demonstrate an understanding of marine hydraulic systems.	Marine hydraulic systems are explained according to operating principles and function.	K2
					The installation and maintenance of marine hydraulic systems is explained with specific reference to steering and trim systems.	K2
				Demonstrate an understanding of marine plumbing systems.	The installation, maintenance and use of marine plumbing systems are explained with specific reference to national and international standards.	K2
					Marine plumbing systems are explained according to operating principles and function.	K2
				Demonstrate an understanding of compressed gas for cooking and heating.	The installation, maintenance and use of compressed gas for cooking and heating are explained according to national and international standards.	K2
Core	376544	Manufacture and install marine joinery components	30	Manufacture joinery components.	Joinery drawings are read and explained using the drawing specifications.	K1/K2
					Joinery components are manufactured according to drawing specification and boat building standards.	K1/K2
				Install marine joinery components.	The installation of marine joinery components is explained to boat building standards.	K1/K2

					Marine joinery components are installed according to drawing specifications.	K1/K2
				Demonstrate the finishing of typical marine joinery components.	Marine Joinery components are finished according to specified quality standards.	K1/K2
Elective	[376543]()	Demonstrate an understanding of inboard engine systems and maintenance	15	Demonstrate an understanding of basic engine systems.	Different engine systems are identified according to their chief characteristics.	K2
					The functions and purpose of each individual engine system are explained in terms of their functions.	K2
				Demonstrate an understanding of the maintenance and servicing requirements of the different engine systems.	The important aspects of servicing each of the engine systems are identified and described.	K2
					The relevant ABYC standards are discussed and explained.	K2
				Demonstrate an understanding of the correct procedure for identifying problems in engine systems.	The procedure for troubleshooting the various engine systems is described.	K2
				Demonstrate an understanding of the principles and operation of marine propulsion systems.	The relationship between the different propeller characteristics are discussed and described.	K2
					A propeller is examined for damage.	K1
					A propeller is removed, inspected and replaced if necessary.	K1
				Engine systems are serviced and maintained.	Engine systems and sub-systems are identified.	K2
					Troubleshooting is undertaken on various engine systems.	K2
					Engine systems are serviced and maintained to meet manufacturer's specifications	K2
					Systems are installed to meet appropriate standard/specification.	K2
Elective	[10783]()	Join of aluminium by means of arc welding	5	Explain the factors critical to joining aluminium by means of arc welding.	1. The process of arc welding and the application of equipment, in accordance with specified requirements.	K2

	2. The importance of joining aluminium by means of arc welding, thus showing a clear understanding of the direct consequences to self and the business.	K2
	3. The possible critical hazards and substandard conditions that may be encountered while joining aluminium by means of arc welding in a particular context and how to deal with them so as to be consistent with accepted best practice.	K2
Prepare to join aluminium by means of arc welding.	1. Permission to enter the workplace, when required, is obtained in accordance with specified requirements.	K2
	2. The required personal protective equipment is selected, examined and used in a way that is consistent with its purpose, design and specified requirements. Personal protective equipment is used to ensure the safety of persons and equipment.	K2
	3. The tools, material and equipment are selected, examined and transported in accordance with specified requirements.	K1/K2
	4. The workplace is examined in accordance with specified requirements and any hazardous and substandard conditions are dealt with in accordance with the prescribed procedures.	K1/K2
	5. Where applicable, a test for the presence of flammable and harmful gases is conducted in accordance with the specified requirements.	K1/K2

	6. The consequences that inadequate preparation for the joining of aluminium by means of arc welding (i.e. not in line with specified requirements and current legislation) may hold for health, safety and production are explained.	K2
Join aluminium by means of arc welding.	1. The required personal protective equipment is used in a way that is consistent with its purpose, design and specified requirements. Personal protective equipment is used to ensure the safety of persons and equipment.	K1/K2
	2. Work-related hazards are dealt with in accordance with specified requirements. Risks associated with joining the aluminium by means of an arc welding are explained.	K2
	3. The aluminium is joined in accordance with specified requirements.	K1/K2
	4. Interpersonal interaction is positive, consistent with specified requirements, promotes effective teamwork, and avoids dysfunctional conflict.	K2
	5. The tools and equipment are used in accordance with manufacturers` design and without injury to self and others.	K1/K2
	6. The consequences for health, safety and production of not joining aluminium by means of arc welding in line with specified requirements and current legislation are explained.	K2
Complete the aluminium arc welding process and prepare for operation and/or production.	1. The selected tools, material and equipment are dealt with in accordance with the specified requirements.	K1/K2
	2. The workplace is cleared and cleaned so as to be free from hazards, in accordance with specified requirements and good	K2

					housekeeping practices.	
					3. The necessary report(s) on the work performed are compiled in compliance with the specified requirements for format, content, accuracy and distribution. The report is submitted within the agreed time.	K2
					4. The consequences for health, safety and production of not joining aluminium by means of arc welding in line with specified requirements and current legislation are explained.	K2
Elective	116714	Lead a team, plan, allocate and assess their work	4	**THIS UNIT STANDARD WAS OMITTED AS IT DOES NOT RELATE TO CORE BOAT BUILDING COMPETENCIES**		
Elective	117877	Perform one-to-one training on the job	4	**THIS UNIT STANDARD WAS OMITTED AS IT DOES NOT RELATE TO CORE BOAT BUILDING COMPETENCIES**		
Elective	116720	Show understanding of diversity in the workplace	3	**THIS UNIT STANDARD WAS OMITTED AS IT DOES NOT RELATE TO CORE BOAT BUILDING COMPETENCIES**		

Level 4 Yacht and Boat building elective and core unit standards, Specific outcomes and assessment criteria

			CREDITS	SPECIFIC OUTCOME	ASSESSMENT CRITERIA	KNOWLEDGE TYPE
Core	376540	Demonstrate an understanding of boat design	15	Calculate displacement and explain its importance in boat building.	Methods for calculating displacement at a design stage are understood.	K2/K4
					The importance of accurately calculating displacement is explained.	K2/K4
					Dispersement calculations are performed for a number of craft using appropriate methods.	K2/K4
				Demonstrate an understanding of stability and methods of calculation in boat design.	The importance of stability in small craft design is explained in terms of the safety of crew, passengers, on-board items and the	K2/K4

					seaworthiness of the craft.	
					Methods of estimating/calculating stability are identified and described.	K2
					Calculations of stability are made according to scientific principle.	K2/K4
				Demonstrate an understanding of rig design.	Different aspects and features of small craft rig design are described and their implications for sailing performance discussed.	K2/K4
					The ways in which variations to small craft rig design may be made are explained focussing on the way in which the variations may positively or negatively affect craft performance.	K2/K4
				Identify and describe the main features of interior boat and yacht layout.	Practical considerations which need to be taken into account for general arrangements and interior layouts for small craft are identified and described.	K2
					A general arrangement drawing is completed with full explanation of all the decisions taken regarding the placement of objects/equipment and interior layout according to principles of interior design.	K2/K4
Core	376580	Demonstrate an understanding of boatbuilding standards	20	Demonstrate an understanding of industry standards in the specification and installation of bilge pumps.	The specifications of bilge pumps are identified and described according to nationally and internationally accepted industry standards.	K2
					Standards for the installation of bilge pumps are explained according to nationally and internationally accepted industry standards.	K2
				Demonstrate an understanding of industry standards in the specification and installation of Marine Electrical Systems.	The specifications of marine electrical systems are identified and described according to nationally and internationally accepted industry standards.	K2

					Standards for the installation of marine electrical systems are explained according to nationally and internationally accepted industry standards.	K2
				Demonstrate an understanding of industry standards in the installation of Engine Exhaust systems.	The specifications of engine exhaust systems are identified and described according to nationally and internationally accepted industry standards.	K2
					Standards for the installation of engine exhaust systems are explained according to nationally and internationally accepted industry standards.	K2
				Demonstrate an understanding of industry standards in the specification and installation of handrails and re-boarding systems.	The specifications of handrails and re-boarding systems are identified and described according to nationally and internationally accepted industry standards.	K2
					Standards for the installation of handrails and re-boarding systems are explained according to nationally and internationally accepted industry standards.	K2
Core	376582	Demonstrate an understanding of structural composites	20	Demonstrate an understanding of plug and mould manufacturing in boat building.	The theory, process and methods of plug manufacture are explained according to boat building principles.	K2/K4
					The theory, process and methods of mould manufacture are explained according to boat building principles.	K2/K4
				Demonstrate an understanding of vacuum bagging, infusion and prepreg.	The materials, equipment and processes for vacuum bagging are explained according to specifications.	K2
					The materials, equipment and processes for infusion are explained according to specifications.	K2
				Demonstrate an understanding of composite structural details.	The tabbing process is explained within the context of boat building.	K2

				Demonstrate an understanding of quality assurance systems in composite construction.	The qualitative and quantitative measurements for final hull inspection are identified and explained according to boat building principles.	K2
					Composite materials management and storage is explained according to best practice and manufacturers' specifications.	K2
Core	376581	Install marine electrical systems	20	Demonstrate an understanding of the theory of marine electrical installations.	Marine electrical calculations are performed using the appropriate formula.	K2
					Parts of a marine electrical system are identified and explained in a boat building context.	K2
				Demonstrate an understanding of the installation of a marine electrical system.	Factors affecting the installation of a marine electrical system are identified and explained according to national and international standards.	K2
					The national and international standards are discussed and explained in terms of marine electrical systems.	K2
				Demonstrate an understanding of the principles and operation of onboard electrical systems.	The installation of marine electrical systems is discussed and explained with specific reference to charging and distribution systems.	K2
					The importance and influence of standards are discussed and with reference to the design and operational safety of electrical systems.	K2
					The maintenance of marine electrical systems is explained in terms of ensuring reliable and efficient as well as cost effective functioning.	K2
					The design and functioning of key components is discussed with reference to the advantages and disadvantages of different designs.	K2
					The importance and influence of standards are discussed and with	K2

					reference to the design and operational safety of electrical systems.	
				Install and maintain a simple marine electrical system	A simple electrical system is planned, which meets appropriate standard/specification.	K1/K2
					Correct components are selected for installation according to suit different applications.	K1/K2
					A simple marine electrical system is correctly installed with appropriate wiring, which functions according to design.	K1/K2
					An on-board electrical system is examined for standards compliance.	K2
					An incorrectly installed on-board electrical system is correctly diagnosed and corrected.	K1/K2
Elective	376545	Apply marine fairing and painting techniques	15	Identify and describe the personal health and safety factors to be considered when working with marine paint and fairing compounds.	Health and safety risks in the workplace are identified and an explanation given of the frequency at which they might occur and the danger they pose to people and the work environment.	K2
					Appropriate workplace health and safety standards are implemented at all times.	K2
					Appropriate action is recommend and/or taken to remedy non-compliance with health and safety requirements.	K2
				Prepare boat surfaces for fairing and painting.	The preparation of the boat surface is explained in accordance with the coating system manufacturer's specifications.	K2
					Highs and lows are marked on the boat surface in order to determine the application of fairing compound according to boat building principles.	K1/K2
				Demonstrate an understanding of yacht and boat fairing techniques.	The process of yacht and boat fairing is described according to boat building principles.	K2

					Fairing techniques are applied during the building/renovation of a boat/yacht ensuring a high quality product and a minimum wastage of materials.	K1/K2
				Demonstrate an understanding of yacht and boat painting techniques and marine coating systems.	Yacht and boat painting techniques are identified and explained according to manufacturer's specifications.	K2
					Painting techniques and marine coating systems and methods are applied during the building/renovation of a boat/yacht ensuring a high quality product and a minimum wastage of materials.	K1/K2
				Troubleshoot common failures in marine coating systems.	Common failures of marine coating systems are described and their causes and remedies identified and discussed.	K2
					Common failures in marine coating systems are identified and solutions to prevent/ remove them are recommended.	K2
Electiv e	263024	Plan and produce two dimensional (2D) Computer Aided Drawings (CAD)	15	Prepare the computer environment for using CAD software.	Computer aided drawing software programme is selected and activated in accordance with the job, software manufacturer's instructions and hardware requirements.	K2
					Programme is customized and configured in relation to available peripherals.	K2
					Preparation of the drawing area suits the task in terms of size, scale, parameters, paper size and orientation.	K2
				Prepare to produce a 2D computer aided drawing.	CAD commands are applied to perform drawing operations in accordance with software functionality.	K1/K2
					Views, Elevations and parameters are drawn to scale and projected according to the requirements of the job.	K1/K2
					Relevant dimensions and assemblies are constructed in	K1/K2

					accordance with final design requirements.	
					Components selected from manufacturer's catalogue and specifications comply with codes of practice for engineering drawing and meet job requirements.	K2
					Multiple sheet drawing layouts are cross-referenced according to organisational requirements.	K1/K2
					Drawing title block, layout, number, type of views and reference data are selected to suit the job.	K1/K2
				Verify the interpretation of job requirements.	Job and worksite drawing requirements are identified and verified in accordance with instructions.	K2
					Interpretation of job requirements is verified with all stakeholders according to organizational procedures.	K2
					Drawing requirements are altered, if required, according to the verification and confirmation.	K2
				Produce a detailed computer aided drawing.	Drawing notes, symbols and presentation detail are identified, produced and positioned where required to comply with code of practice.	K1/K2
					Drawing is saved to file according to organisational procedures.	K1/K2
					Draft copy is printed, checked and modified where necessary to ensure compliance and completeness.	K1/K2
					Final copy is printed and verified to meet job requirements within agreed time frames.	K1/K2
					Final administrative and office procedures are carried out according to organizational requirements.	K1/K2
Electiv e	117166	Use CNC machinery in the furniture production process	10	Prepare machinery and materials.	Specifications are checked and confirmed to be clear, accurate and complete.	K2
					Any queries regarding the specification is	K2

	clarified with the relevant person.	
	Resources are identified and accessed.	K2
	The compatibility of materials with the C.N.C machine and tooling to be used is accurately confirmed.	K2
	Correct remedial action is taken in the event of defects and discrepancies in materials and machinery.	K2
	The operation is performed safely and within the time allocated.	K1
	Documentation is accurate and complete.	K2
	Own work practices minimise the risk of injury and damage to machinery and the Health and Safety of self and others.	K2
Set up machinery.	Dimensional control aids are correct and appropriate for the job to be carried out.	K1/K2
	Tooling is accurately and correctly positioned and secured.	K1/K2
	Tools, component references and programmes are selected and entered correctly.	K1/K2
	Programme proving and modification is undertaken correctly.	K1/K2
	The C.N.C machine is confirmed to be ready for safe and effective production.	K1/K2
	Correct remedial action is taken in the event of defects and discrepancies in programmes.	K1/K2
	The operation is performed safely and within the time allocated.	K1/K2
	Documentation is accurate and complete.	K2
	Own work practices minimise the risk of injury and damage to machinery and the Health and Safety of self and others.	K2
Operate machinery.	All Health and Safety requirements are adhered to prior to	K2

	activating the machine.	
	Materials are checked and confirmed to conform with specification.	K2
	Non-conformity of materials to specification are reported to the relevant person and replaced.	K2
	Where necessary assistance are in place prior to and during operations.	K2
	C.N.C machinery is activated and de-activated safely and correctly.	K1/K2
	Materials are confirmed to be compatible with machinery.	K2
	Compliance with guards and other Health and Safety requirements are continually established during the operations.	K2
	Finished components and products conform to specification requirements.	K2
	Necessary documentation is completed accurately.	K2
	Own work practices minimise risk of injury and damage to machinery and Health and Safety of self and others.	K2
	Operations are performed safely and within the time allocated.	K2

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED QUALIFICATION:

National Certificate: Yacht and Boat Building

SAQA QUAL ID	QUALIFICATION TITLE
77003	National Certificate: Yacht and Boat Building

ORIGINATOR	ORIGINATING PROVIDER
SGB Manufacturing and Assembly Processes	

QUALITY ASSURING BODY
MERSETA - Manufacturing, Engineering and Related Services Education and Training Authority

QUALIFICATION TYPE	FIELD	SUBFIELD
National Certificate	Field 06 - Manufacturing, Engineering and Technology	Manufacturing and Assembly

ABET BAND	MINIMUM CREDITS	OLD NQF LEVEL	NEW NQF LEVEL	QUAL CLASS
Undefined	136	Level 2	NQF Level 02	Regular-Unit Stds Based

REGISTRATION STATUS	SAQA DECISION NUMBER	REGISTRATION START DATE	REGISTRATION END DATE
Registered	SAQA 0486/10	2010-06-02	2013-06-02

LAST DATE FOR ENROLMENT	LAST DATE FOR ACHIEVEMENT
2014-06-02	2017-06-02

In all of the tables in this document, both the old and the new NQF Levels are shown. In the text (purpose statements, qualification rules, etc), any reference to NQF Levels are to the old levels unless specifically stated otherwise.

This qualification replaces:

Qual ID	Qualification Title	Old NQF Level	New NQF Level	Min Credits	Replacement Status
50542	National Certificate: Small Craft Construction	Level 2	NQF Level 02	156	Complete

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of this qualification is to prepare qualifying learners for a career in yacht and boatbuilding, to provide an opportunity for people currently employed in the industry to achieve formal recognition for their accumulated knowledge and skills and to enable them to advance in a structured career and learning path, and to facilitate the economic growth and development of the South African boatbuilding industry.

Qualifying learners will have developed basic boatbuilding skills, knowledge and understanding, which include:

- An understanding of the boatbuilding environment, including a broad understanding of different boatbuilding techniques and their applicability to the different materials commonly used for boatbuilding.
- A practical understanding of workshop safety.
- Selecting and safely operating the appropriate basic hand and power tools commonly used in boatbuilding.
- Operating basic power machinery used in woodworking applications in boatbuilding.
- A basic understanding of laminating materials with specific reference to boatbuilding applications.
- Basic laminating skills.

Learners acquiring this qualification will have an improved understanding of their role, and acquire the applied competencies to consistently and effectively execute their duties by contributing to the manufacturing process, and adhering to quality and safety requirements.

Rationale:

The boat building industry is a complex and specialised sector supplying a vast range of quality boats to customers. The emergence of South Africa as a cost effective supplier to international markets has created a demand for people with the skills to build yachts and boats as well as to perform support functions in a boat building process. These processes include laminating, marine joinery, boat design and construction, metalwork, complying with international boat building standards, installing and maintaining marine electrical systems and inflatable boat technology.

This is the first in a series of qualifications in yacht and boat building starting at NQF Level 2 and progressing to NQF Level 4. This series of qualifications will enable learners to:

- Develop their existing skill level and progress vertically in a selected career path within the yacht and boat building industry.
- Receive recognition for experience gained in the work place through an RPL process.
- Obtain skills and knowledge that are portable within similar manufacturing industries.
- Gain access to higher levels of learning and learning provision.
- Access opportunities to progress in their personal life and career and add value to the operations in which they function.
- Contribute to the growth of the South African economy and society.

This learning pathway addresses the full skills requirements of the boatbuilding sector and will prepare qualifying learners for the broad range of activities that must be undertaken by the competent boatbuilder, whilst at the same time providing a sound base for further learning.

People working in the yacht and boat building sector require validation of their skills and experience through access to formal qualifications and standards. The qualification affirms the experiences of boat builders through the recognition of prior learning, credit accumulation and achievement of competencies. It also provides learners with opportunities for professional development and career advancement within the broader manufacturing environment.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

It is assumed that learners are already competent in:

- Communication and Mathematical Literacy at NQF Level 1 or equivalent.

Recognition of Prior Learning:

The structure of this unit standards-based qualification makes the Recognition of Prior Learning possible. This qualification may therefore be achieved in part or completely through the recognition of prior learning, which includes formal, informal and non-formal learning and work experience. The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the Recognition of Prior Learning option towards gaining a qualification.

If the learner is able to demonstrate competence in the knowledge, skills, values and attitudes implicit in this qualification the appropriate credits should be assigned to the learner. Recognition of

Prior Learning will be done by means of Integrated Assessment as mentioned above.

This Recognition of prior learning may allow:

- Accelerated access to further learning at this or higher levels on the NQF.
- Gaining of credits towards a unit standard.
- Obtaining of this Qualification in part or in whole.

Access to the Qualification:

- This qualification is open for learners whose mobility on a standard boat would not be restricted due to any disabilities.

RECOGNISE PREVIOUS LEARNING?

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QUALIFICATION RULES

The Qualification is made up of Fundamental, Core, and Elective unit standards and a minimum of 136 Credits are required to complete the Qualification.

In this Qualification the credits are allocated as follows:

- Fundamental: 36 Credits.
- Core: 90 Credits.
- Electives: 10 Credits (minimum).

Total: 136 Credits.

The Fundamental Component:

The Fundamental Component consists of Unit standards to the value of 20 Credits in Communication in a South African language at NQF Level 2 and Unit standards in Mathematical Literacy at NQF Level 2 to the value of 16 Credits. All the Fundamental unit standards are compulsory.

The Core Component:

Yacht and Boat Building, can be differentiated from most other trades by the extremely wide range of core competencies that are required by the technically competent practitioner. A high level of skill and understanding are necessary in activities as diverse as joinery, metalwork, fibreglass fabrication, and electrical, mechanical and plumbing installation for the professional boatbuilder.

This Core component covers competencies related to boat building practices, health, safety and environmental issues, tools and equipment, manufacturing processes and materials. The unit standards provide the knowledge, values and skills that all learners require in order to engage in boat building practices.

All the Unit standards to the value of 90 credits in the Core Component are compulsory.

Elective Component:

Learners are to choose elective unit standards to the value of at least 10 Credits to complete the qualification.

EXIT LEVEL OUTCOMES

1. Demonstrate an understanding of the boatbuilding environment, including a broad understanding of different boatbuilding techniques and their applicability to the different materials commonly used for boatbuilding.

2. Demonstrate a practical understanding of workshop safety.

3. Demonstrate a basic understanding of composite materials with specific reference to boatbuilding

applications.

4. Use basic laminating techniques.

Critical Cross-Field Outcomes:

1. Identify and solve problems in which response displays that responsible decisions, using critical and creative thinking, have been made by:

- Identification of materials.
- Identification of hull forms and features.
- Identification of causes of problems.
- Identification of different problems resulting from inappropriate material or tool selection and potential solutions.

2. Work effectively with others as a member of a team, group, organisation or community by:

- Liaising with team members and supervisor.

3. Organise and manage oneself and ones' activities responsibly and effectively by:

- Plan sequence of operations based on job specification.

4. Collect, analyse, organise and evaluate information by:

- Examine finished product for non-conformances.

5. Communicate well orally or in writing:

- Record information on work performed.
- Report outcome of work to supervisors.

6. Demonstrate an understanding of the world as a set of related systems:

- Explain the consequences of inappropriate hull type selection.
- Explain the consequences of inappropriate material or production process selection.

7. Use science and technology effectively and critically by:

- Understanding of material properties.
- Understanding of construction processes.
- Understand measuring and drawing techniques.
- Understand fairing techniques.
- Understand measuring and mixing equipment and techniques.

ASSOCIATED ASSESSMENT CRITERIA

Associated Assessment Criteria for Exit Level Outcome 1:

- Different types of small craft and their specific distinguishing characteristics are identified and described.
- The main parts of a boat are identified and their basic functionality described.
- Different boatbuilding techniques are described and their applicability to the major boatbuilding materials explained.

Associated Assessment Criteria for Exit Level Outcome 2:

- The work area is kept in a safe and productive state through the application of health and safety standards.
- Personal protective equipment is used according to health and safety standards.

Associated Assessment Criteria for Exit Level Outcome 3:

- Different types of reinforcement material are described and identified, and their main properties and uses explained.
- Different types of matrix material are described and identified and their main properties and uses discussed.
- Different types of core material are described and identified and their main properties and uses discussed.

Associated Assessment Criteria for Exit Level Outcome 4:

- Resins are measured and mixed according to specifications.
- Reinforcements are selected, prepared and positioned according to specifications.
- Basic hand-laminating techniques are applied.

Integrated Assessment:

- Assessment practices must be open, transparent, fair, valid, and reliable and ensure that no learner is disadvantaged in any way whatsoever, so that an integrated approach to assessment is incorporated into the qualification.
- Learning, teaching and assessment are inextricably interwoven. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the unit standards should be integrated.
- Assessment of Communication and Mathematical Literacy should be integrated as far as possible with other aspects and should use practical administration contexts wherever possible. A variety of methods must be used in assessment and tools and activities must be appropriate to the context in which the learner is working or will work. Where it is not possible to assess the learner in the workplace or on-the-job, simulations, case studies, role-plays and other similar techniques should be used to provide a context appropriate to the assessment.
- The term `Integrated Assessment` implies that theoretical and practical components should be assessed together. During integrated assessments, the assessor should make use of a range of formative and summative assessment tool methods and assess combinations of practical, applied, foundational and reflective competencies.
- Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience.
- Assessment should ensure that all specific outcomes, embedded knowledge and critical cross-field outcomes are evaluated in an integrated manner.

INTERNATIONAL COMPARABILITY

The South African boatbuilding qualifications have been developed to fit into the NQF system where a series of qualifications is developed at successive NQF Levels, each of which can be awarded to learners on completion, while full competence as a boatbuilder is only attained on completion of all the qualifications in the series. International practice, on the other hand, is that there is one large qualification encompassing the full range of competencies, skills and knowledge, which has to be completed for the person to be equipped as a competent boatbuilder. Learners internationally only receive the comprehensive qualification and not smaller, step-by step qualifications. This makes it difficult to compare the qualifications on a level by level basis with other qualifications from around the world.

While the qualified South African boat builder may ultimately have very similar skills, and a comparable level of knowledge to boatbuilders in different countries, the process of developing these is quite distinct in South Africa.

This qualification was compared with training offered in countries that are acknowledged leaders in the small boat-building industry i.e. countries whose industry supplies small craft to other countries. These countries are:

- USA.
- Malaysia.
- Turkey.
- Australia.
- New Zealand.
- UK.

The United Kingdom:

The United Kingdom is renowned for their boat building expertise and there are several national registered qualifications, however, it seems that many training providers still present their own traditional learning programs based on the learner's years of experience and specific manufacturer's needs. The UK is the only country that offers qualifications on consecutive 'levels' in a similar way to South Africa, but only does so at two levels, namely level 2 and level 3. In the UK there are very well established boatbuilding schools which offer the full range of training in a specialist practical environment. May of the programmes include theoretical examinations which students do online, while they have to demonstrate competence through a series of assignments managed and assessed at their boat building yard. The South African boat building qualifications are much more comprehensive.

New Zealand:

New Zealand offers qualifications at level 3 and level 4, but the qualifications are distinct and do not follow on from one another. By far the majority of the qualifications are at level 4, and the prospective boatbuilder would spend between three and five years accumulating the necessary credits, skills and experience to attain the level 4 qualification without first acquiring a level 2 or level 3 qualification along the way. In New Zealand there is a very well developed tradition of practical training being done in boatyards, and learners develop all their skill and experience in the workplace and attend polytechnics or universities for the theoretical content only.

In general the contents of the South African boat building qualifications, taking the level 2, 3 and 4 qualifications as a whole, compare well with the New Zealand boat building qualifications.

United States of America:

The American Boat and Yacht Council (ABYC) have a well developed professional certification process which covers the majority of the core boatbuilding skills. This series of South African boatbuilding qualifications (levels 2, 3 and 4) focuses on the same core knowledge and skills, and the successful learner should be well prepared for ABYC certification on completion of all three qualifications.

Turkey:

The boating industry in Turkey is well developed. A technical high school, Kurucasile, on the Black Sea Coast of Turkey, is devoted to boat building only. This school, in addition to modern techniques, teaches its students, elements and principles of traditional craftsmanship. A number of other schools and academic institutions also run diploma courses in boatbuilding, which include practical components being learned at large yards. All these diplomas are valid nationwide. These programmes and courses consist of all the skills and knowledge required by a boatbuilder and are not shorter certificate courses given to successful learners who have mastered only some of the skills and knowledge required. Diplomas issued by large universities (such as the naval architect diplomas issued by most technical universities) are internationally recognised.

Australia:

Australia has a well-established boat-building industry supported by well-defined units of study to be offered by training providers. Their learning programs in boat building do not seem to follow levels of complexity. It is very difficult to compare the South African individual boat building qualifications with those in Australia. However, it seems that once South African learners have completed the Further Education and Training Certificate: Boatbuilding and the preceding two qualifications at Level 2 and 3, they will be adequately equipped to compete with their Australian counterparts.

Malaysia:

Malaysia is an emerging boat building country. To date they have not developed a formal national qualification. They have however identified future training objectives and are in the process of developing learning programmes for the manufacture of fibreglass boats.

Africa in General:

Although many countries in Africa have displayed the capability to build boats of many shapes and sizes it still lacks the capability to build modern boats. No evidence was found of any boat building training being presented in sub-Saharan Africa. The South African qualifications could help to fill that gap on the continent by making these qualifications available to all those countries that might show an interest in these qualifications.

Conclusion:

Other countries all have a certain assumed level of basic education and do not attempt to combine teaching of Mathematics and Communication Fundamentals with the qualifications in the same way as the NQF in South Africa. While this is in response to a particular South African need, it further contributes to the local qualification being quite different in nature from any of its international counterparts.

The cumulative content of the South African qualifications (Levels 2, 3 and 4) is broader than would be required in Australia, Canada, New Zealand and the UK, but very similar to the recently developed ABYC qualifications in the USA. In the other countries, while the full scope of skills and knowledge are available as qualifications, students tend to specialise in more specific areas and so achieve a boat building qualification with a particular area of focus.

The South African qualifications offer learners a number of sequential shorter qualifications, while the other countries offer qualifications at the end of a longer, but possibly more narrowly focused period of learning.

Level 2:

In Level 2, learners receive an introduction to the working environment, workplace health and safety training, and entry level skills and boat building knowledge very similar to what they would receive in all the other countries, with the primary difference being that they receive a Level 2 qualification at the end of it. The South African qualification includes Fundamentals in Mathematical Literacy and Communication which the others do not.

Level 3:

In Level 3, students build on the knowledge and skills acquired at Level 2 in a very similar fashion to the other countries studied, with the main difference again being the awarding of a level 3 qualification upon completion, and the inclusion of further Mathematical Literacy and Communication Fundamentals.

In terms of levels, the level 3 falls between the UK Level 2 and Level 3, and is similar to the New Zealand Level 3, although in New Zealand no interim qualification is awarded.

Level 4:

At Level 4 the learner hones his/her skills, and refines his/her knowledge of boatbuilding, and upon completion, the successful learner will have achieved an almost identical level of theoretical knowledge to his counterpart following the ABYC syllabus in the USA, but will achieve the qualification with slightly less experience. Likewise, the New Zealand, Australian and Canadian students will have more workplace experience and a slightly narrower theoretical basis, while the UK student will have less experience and a slightly narrower knowledge base, but much more intensive practical training.

As stated in the beginning, it is very difficult to compare unlike levels and systems across countries, and each system will naturally have its own benefits and drawbacks. The content of the South African qualification is as comprehensive as any other and broader than most, but the way of delivering the training and the assessment thereof are quite different.

ARTICULATION OPTIONS

This Qualification articulates with the following Qualifications:

Horizontal articulation:

- ID 49091: National Certificate: Furniture Making: Wood, NQF Level 2.

Vertical articulation:

- ID 49105: National Certificate: Furniture Making: Wood, NQF Level 3.
- ID 78863: National Certificate: Yacht and Boat Building, NQF Level 3.

MODERATION OPTIONS

- Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education and Training Quality Assurance Body (ETQA) or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Any institution offering learning that will enable the achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA`s policies and guidelines for assessment and moderation.

- Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

For an applicant to register as an assessor, the applicant needs:

- To be registered as an assessor with the relevant Education and Training Quality Assurance Body.
- A relevant qualification at one level higher than the level of the qualification and 12 months experience in the relevant field.
- Well-developed subject matter expertise within boat building.

NOTES

This qualification replaces qualification 50542, "National Certificate: Small Craft Construction", Level 2, 156 credits.

UNIT STANDARDS:

	ID	UNIT STANDARD TITLE	OLD LEVEL	NEW LEVEL	CREDITS
Core	365146	Apply a range of boat design and construction principles	Level 2	NQF Level 02	20
Core	365159	Demonstrate a practical understanding of marine joinery	Level 2	NQF Level 02	30
Core	365145	Demonstrate an understanding of corrosion and basic metalwork in a marine environment	Level 2	NQF Level 02	10
Core	365143	Demonstrate an understanding of inflatable boat technology	Level 2	NQF Level 02	5
Core	110281	Fabricate a polymer composite product	Level 2	NQF Level 02	9
Core	110289	Identify and work with material as required for polymer composite fabrication	Level 2	NQF Level 02	8
Core	13220	Keep the work area safe and productive	Level 2	NQF Level 02	8
Fundamental	119463	Access and use information from texts	Level 2	NQF Level 02	5

Fundamental	12461	Communicate at work	Level 2	NQF Level 02	5
Fundamental	7480	Demonstrate understanding of rational and irrational numbers and number systems	Level 2	NQF Level 02	3
Fundamental	9008	Identify, describe, compare, classify, explore shape and motion in 2-and 3-dimensional shapes in different contexts	Level 2	NQF Level 02	3
Fundamental	119454	Maintain and adapt oral/signed communication	Level 2	NQF Level 02	5
Fundamental	12444	Measure, estimate and calculate physical quantities and explore, describe and represent geometrical relationships in 2-dimensions in different life or workplace contexts	Level 2	NQF Level 02	3
Fundamental	119460	Use language and communication in occupational learning programmes	Level 2	NQF Level 02	5
Fundamental	7469	Use mathematics to investigate and monitor the financial aspects of personal and community life	Level 2	NQF Level 02	2
Fundamental	9007	Work with a range of patterns and functions and solve problems	Level 2	NQF Level 02	5
Elective	123600	Demonstrate seamanship for the safe crewing of a small craft	Level 2	NQF Level 02	10
Elective	12465	Develop a learning plan and a portfolio for assessment	Level 2	NQF Level 02	6
Elective	12484	Perform basic fire fighting	Level 2	NQF Level 02	4
Elective	12483	Perform basic first aid	Level 2	NQF Level 02	4
Elective	119753	Perform basic welding/joining of metals	Level 2	NQF Level 02	8
Elective	12481	Sling loads	Level 2	NQF Level 02	4

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION:

When qualifications are replaced, some (but not all) of their learning programmes are moved to the replacement qualifications. If a learning programme appears to be missing from here, please check the replaced qualification.

NONE

PROVIDERS CURRENTLY ACCREDITED TO OFFER THIS QUALIFICATION:

This information shows the current accreditations (i.e. those not past their accreditation end dates), and is the most complete record available to SAQA as of today. Some Quality Assuring Bodies have a lag in their recording systems for provider accreditation, in turn leading to a lag in notifying SAQA of all the providers that they have accredited to offer qualifications and unit standards, as well as any extensions to accreditation end dates. The relevant Quality Assuring Body should be notified if a record appears to be missing from here.

NONE

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED QUALIFICATION:

National Certificate: Yacht and Boat Building

SAQA QUAL ID	QUALIFICATION TITLE

78863	National Certificate: Yacht and Boat Building			
ORIGINATOR		**ORIGINATING PROVIDER**		
SGB Manufacturing and Assembly Processes				
QUALITY ASSURING BODY				
MERSETA - Manufacturing, Engineering and Related Services Education and Training Authority				
QUALIFICATION TYPE	**FIELD**		**SUBFIELD**	
National Certificate	Field 06 - Manufacturing, Engineering and Technology		Manufacturing and Assembly	
ABET BAND	**MINIMUM CREDITS**	**OLD NQF LEVEL**	**NEW NQF LEVEL**	**QUAL CLASS**
Undefined	136	Level 3	NQF Level 03	Regular-Unit Stds Based
REGISTRATION STATUS		**SAQA DECISION NUMBER**	**REGISTRATION START DATE**	**REGISTRATION END DATE**
Registered		SAQA 0486/10	2010-06-02	2013-06-02
LAST DATE FOR ENROLMENT		**LAST DATE FOR ACHIEVEMENT**		
2014-06-02		2017-06-02		

In all of the tables in this document, both the old and the new NQF Levels are shown. In the text (purpose statements, qualification rules, etc), any reference to NQF Levels are to the old levels unless specifically stated otherwise.

This qualification replaces:

Qual ID	Qualification Title	Old NQF Level	New NQF Level	Min Credits	Replacement Status
50543	National Certificate: Small Craft Construction	Level 3	NQF Level 03	122	Complete

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of this qualification is, to prepare qualifying learners for a career in boatbuilding, to provide an opportunity for people currently employed in the industry to achieve formal recognition for their accumulated knowledge and skills and to enable them to develop a structured career path, as well as to facilitate the economic growth and development of the South African boatbuilding industry.

Qualifying learners will have developed core boatbuilding skills, knowledge and understanding, which include:

- An understanding of the lines drawing and standards and techniques.
- A practical understanding of the safe operation and maintenance of woodworking tools and machinery encountered in boatbuilding applications.
- An understanding of the main on-board systems relevant to boatbuilding and identify their major components.
- An understanding of the properties of resin, reinforcement and core materials, and their practical application in the construction and repair of composite components.

Learners acquiring this qualification will have an improved understanding of their role, and acquire the applied competencies to consistently and effectively execute their duties by contributing to the manufacturing process, and adhering to quality and safety requirements.

This qualification reflects the need and demand within the small craft construction sector for skilled employees. Successful learners will be able to manufacture world-class products, improve professionalism and enhance the general quality of service delivery in the industry, thereby contributing positively to investor confidence and the international competitiveness of the South African small craft construction sector.

Rationale:

The boat building industry is a complex and specialized sector supplying a vast range of quality boats to customers. The emergence of South Africa as a cost effective supplier to international markets has created a demand for people with the skills to build yachts and boats as well as function within the support processes of a building process. These processes include but not limited to: boat design and construction techniques, installation and maintenance of marine systems, manufacture and installation of marine joinery components, construct and repair composite marine components and understand marine inboard engines.

This is the second in a series of qualifications in yacht and boat building starting at NQF Level 2 and progressing to NQF Level 4. This series of qualifications will enable learners to:

- Develop their existing skill level and progress vertically in a selected career path within the yacht and boat building industry.
- Receive recognition for experience gained in the work place through Recognition of Prior Learning process.
- Obtain skills and knowledge portable within similar manufacturing industries.
- Gain access to higher levels of learning and learning provision.
- Access opportunities to progress in their personal life and career, and add value to the operations in which they function.
- Contribute to the growth of the South African economy and society.

This learning pathway addresses the full skills requirements of the boatbuilding sector and will prepare qualifying learners for the broad range of activities that must be undertaken by the competent boat builder, whilst at the same time providing a sound base for further learning.

People working in the yacht and boat building sector require validation of their skills and experience through access to formal qualifications and standards. The qualification affirms the experiences of boat builders through the recognition of prior learning, credit accumulation and achievement of competencies. It also provides learners with opportunities for professional development and career advancement within the broader manufacturing environment.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

It is assumed that learners are already competent in:

- Communication and Mathematical Literacy at NQF Level 2.

Recognition of Prior Learning:

The structure of this unit standards-based qualification makes the Recognition of Prior Learning possible. This qualification may therefore be achieved in part or completely through the recognition of prior learning, which includes formal, informal and non-formal learning and work experience. The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the Recognition of Prior Learning option towards gaining a qualification.

If the learner is able to demonstrate competence in the knowledge, skills, values and attitudes implicit in this qualification the appropriate credits should be assigned to the learner. Recognition of Prior Learning will be done by means of Integrated Assessment as mentioned above.

This Recognition of Prior Learning may allow:

- Accelerated access to further learning at this or higher levels on the NQF.
- Gaining of credits towards a unit standard.
- Obtaining of this Qualification in part or in whole.

Access to the Qualification:

There is open for learners whose mobility on a boat will not be restricted due to any disabilities. It is preferable that learners first complete the National Certificate: Yacht and Boat Building, NQF Level 2 before accessing this qualification.

RECOGNISE PREVIOUS LEARNING?

Y

QUALIFICATION RULES

The Qualification is made up of Fundamental, Core, and Elective unit standards and a minimum of 136credits are required to complete the Qualification.

In this Qualification the credits are allocated as follows:

- Fundamental: 36 credits.
- Core: 85 credits.
- Electives: 15 credits (minimum).
- Total: 136 credits.

The Fundamental Component:

The Fundamental Component consists of Unit standards to the value of 20 credits in Communication in a South African language at Level 2 and Unit standards in Mathematical Literacy at NQF Level 2 to the value of 16 credits. All the Fundamental unit standards are compulsory.

The Core Component:

Yacht and Boat Building, can be differentiated from most other trades by the extremely wide range of core competencies that are required by the technically competent practitioner. A high level of skill and understanding are necessary in activities as diverse as joinery, metalwork, fibreglass fabrication, and electrical, mechanical and plumbing installation for the professional boatbuilder.

This Core component covers competencies related to boat building practices, health, safety and environmental issues, tools and equipment, manufacturing processes and materials. The unit standards provide the knowledge, values and skills that all learners require in order to engage in boat building practices.

All the Unit standards to the value of 85 credits in the Core Component are compulsory.

Elective Component:

Learners are to choose elective unit standards to the value of at least 15 credits to complete the qualification.

EXIT LEVEL OUTCOMES

Qualifying learners are able to:

1. Demonstrate an understanding of lines drawing standards and techniques.

2. Understand the safe operation and maintenance of the full range of woodworking tools and

machinery commonly encountered in boatbuilding applications and use them accordingly.

3. Install the main on-board systems relevant to boatbuilding and identify their major components.

4. Understand the properties of resin, reinforcement and core materials, and use them in the construction and repair of composite components.

Critical Cross-Field Outcomes:

Identify and solve problems:

- Identification of different design features. Evident in Exit Level Outcome 1.
- Identification of causes of problems. Evident in Exit Level Outcome 1, 3 and 4.
- Identification of different problems resulting from inappropriate material, tool or finish selection and potential solutions. Evident in Exit Level Outcome 2.
- Identification of different materials. Evident in Exit Level Outcome 3.
- Identification of different components. Evident in Exit Level Outcome 4.

Work effectively with others in teams:

- Liaising with team members and supervisor. Evident in all Exit Level Outcomes.

Organise oneself effectively:

- Plan sequence of operations based on job specification. Evident in Exit Level Outcome 1, 3 and 4.

Collect, analyse, organise and evaluate information:

- Examine finished product for non-conformances. Evident in Exit Level Outcome 1, 3 and 4.

Communicate well orally or in writing:

- Record information on work performed. Evident in all Exit Level Outcomes.
- Report outcome of work to supervisor. Evident in all Exit Level Outcomes.

Use science and technology responsibly:

- Understanding of three dimensional shapes and their properties. Evident in Exit Level Outcome 1.
- Understanding of materials. Evident in Exit Level Outcome 2.
- Understand measuring and calculating techniques. Evident in Exit Level Outcome 1.
- Understanding of material properties. Evident in Exit Level Outcome 3 and 4.
- Understand measuring and mixing equipment and techniques. Evident in Exit Level Outcome 3.
- Understand tension, stress, flow rate and pressure. Evident in Exit Level Outcome 4.

Understand that the world is a set of related systems:

- Explain the consequences of incorrect calculation of areas, volumes and their centroids. Evident in Exit Level Outcome 1.
- Explain the consequences of inappropriately selecting the main features involved in rudder design. Evident in Exit Level Outcome 1.
- Explain the consequences of inappropriate component selection or incorrect installation and the resulting effects on the installed system. Evident in Exit Level Outcome 4.
- Explain the consequences of inappropriate material or finish selection and the impact that this may have on related systems. Evident in Exit Level Outcome 2 and 3.

ASSOCIATED ASSESSMENT CRITERIA

Associated Assessment Criteria for Exit Level Outcome: 1

- The design of yachts and boats is identified and explained according to main features and principles.
- The lines plan features are identified and their inter-relationships explained according to specifications.

Associated Assessment Criteria for Exit Level Outcome: 2

- The full range of hand and power tools are correctly used and maintained.
- The full range of woodworking machinery used in boatbuilding applications is used and maintained.
- Marine-specific joinery projects are undertaken and finished products comply with specifications and standards.

Associated Assessment Criteria for Exit Level Outcome: 3

- Marine systems are identified and their major components described and discussed.
- Marine systems are installed according to specification and relevant standards.

Associated Assessment Criteria for Exit Level Outcome: 4

- The properties of different types of resin, reinforcement and core materials are described with particular reference to their suitability for different applications.
- Repairs are successfully carried out on damaged composite parts.
- New composite parts are fabricated that comply with initial specifications and relevant standards requirements.

Integrated Assessment:

- Assessment practices must be open, transparent, fair, valid, and reliable and ensure that no learner is disadvantaged in any way whatsoever, so that an integrated approach to assessment is incorporated into the qualification.
- Learning, teaching and assessment are inextricably interwoven. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the unit standards should be integrated.
- Assessment of Communication and Mathematical Literacy should be integrated as far as possible with other aspects and should use practical administration contexts wherever possible. A variety of methods must be used in assessment and tools and activities must be appropriate to the context in which the learner is working or will work. Where it is not possible to assess the learner in the workplace or on-the-job, simulations, case studies, role-plays and other similar techniques should be used to provide a context appropriate to the assessment.
- The term `Integrated Assessment` implies that theoretical and practical components should be assessed together. During integrated assessments, the assessor should make use of a range of formative and summative assessment tool methods and assess combinations of practical, applied, foundational and reflective competencies.
- Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience.
- Assessment should ensure that all specific outcomes, embedded knowledge and critical cross-field outcomes are evaluated in an integrated manner.

INTERNATIONAL COMPARABILITY

This qualification was compared with training offered in countries that are acknowledged leaders in the small boat-building industry; countries whose industry supplies small craft to others. These countries are:

- USA.
- Malaysia.
- Turkey.
- Australia.
- New Zealand.
- UK.

United States of America:

The American Boat and Yacht Council (ABYC) have a well developed professional certification process for the majority of core boatbuilding skills. This qualification focuses on the same core knowledge and skills, and the successful student should be well prepared for ABYC certification.

Malaysia:

Malaysia is an emerging boat building country. To date they have not developed a formal national qualification. They have however identified future training objectives and are in the process of developing learning programmes for fibreglass boats.

Turkey:

The boating industry in Turkey is well developed. A technical high school, Kurucasile, on the Black Sea Coast of Turkey, is devoted to boat building only. This school, in addition to modern techniques, teaches its students, elements and principles of traditional craftsmanship. All the schools and academic institutions, issue diplomas to students who have attended the necessary courses and fulfilled all conditions, including tests and exams. In addition, people attending and successfully finishing the training courses held at various places, such as large yards, and other institutions, are given certificates declaring that the holder has completed a certain program. All these diplomas and certificates are valid nationwide. Diplomas issued by large universities (such as the naval architect diplomas issued by most technical universities) are internationally recognized.

Australia:

Australia has a well-established boat-building industry supported by well-defined units of study to be applied by training providers. Their learning programs in boat building do not seem to follow levels of complexity but rather that of completeness. It is very difficult to compare the South African individual boat building qualifications with those in Australia. However, it seems that once South African learners had completed the Further Education and Training Certificate in Boat Building, they will be adequately equipped to compete with their Australian counterparts.

New Zealand:

The New Zealand authorities compiled a range of national certificates that can be applied in the boat building industry. Most of these certificates are at level 4 with the exception of one that is registered at level 3. In general the contents of the South African boat building qualifications compares well with the New Zealand boat building qualifications.

United Kingdom:

The United Kingdom is renowned for their boat building expertise and similarly displays a well-thought-out capability to train towards that expertise. The UK has several national registered qualifications, however, it does seem as though many training providers still present their own traditional learning programs based on years of experience and specific community needs. It is thought that the South African boat building qualifications are much more comprehensive.

Africa in General:

Although many countries in Africa have displayed across the continent the capability to build boats of many shapes and sizes it still lacks the capability to build modern boats. No evidence was found of any boat building training being presented in sub-Saharan Africa. The South African qualifications could help to fill that gap on the continent by making these qualifications available to all those countries that might show an interest in these qualifications.

ARTICULATION OPTIONS

This Qualification articulates with the following proposed and registered Qualifications:

Horizontal Articulation:

- ID 36155: National Certificate in Polymer Composite Fabrication, NQF Level 3.
- ID 49105: Further Education and Training Certificate: Furniture Making: Wood, NQF Level 3.

Vertical Articulation:

- ID 50560: Further Education and Training Certificate: Small Craft Construction, NQF Level 4.
- ID 36153: Further Education and Training Certificate: Polymer Composite Fabrication, NQF Level 4.
- ID 49092: Further Education and Training Certificate: Furniture Making: Wood, NQF Level 4.
- ID 78864: Further Education and Training Certificate: Yacht and Boat Building, NQF Level 4.

MODERATION OPTIONS

- Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education and Training Quality Assurance Body (ETQA) or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Any institution offering learning that will enable the achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA`s policies and guidelines for assessment and moderation.

- Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

For an applicant to register as an assessor, the applicant needs:

- To be registered as an assessor with the relevant Education and Training Quality Assurance Body.
- A relevant qualification at one level higher than the level of the qualification and 12 months experience in the relevant field.
- Well-developed subject matter expertise within small craft construction.

NOTES

This qualification replaces qualification 50543, "National Certificate: Small Craft Construction", Level 3, 122 credits.

UNIT STANDARDS:

	ID	UNIT STANDARD TITLE	OLD LEVEL	NEW LEVEL	CREDITS
Core	376541	Apply a range of boat design and construction techniques	Level 3	NQF Level 03	15

Core	376560	Construct and repair composite marine components	Level 3	NQF Level 03	15
Core	376542	Install and maintain a range of marine systems	Level 3	NQF Level 03	25
Core	376544	Manufacture and install marine joinery components	Level 3	NQF Level 03	30
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	NQF Level 03	5
Fundamental	9010	Demonstrate an understanding of the use of different number bases and measurement units and an awareness of error in the context of relevant calculations	Level 3	NQF Level 03	2
Fundamental	9013	Describe, apply, analyse and calculate shape and motion in 2-and 3-dimensional space in different contexts	Level 3	NQF Level 03	4
Fundamental	119457	Interpret and use information from texts	Level 3	NQF Level 03	5
Fundamental	9012	Investigate life and work related problems using data and probabilities	Level 3	NQF Level 03	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	NQF Level 03	5
Fundamental	7456	Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	Level 3	NQF Level 03	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	NQF Level 03	5
Elective	376543	Demonstrate an understanding of inboard engine systems and maintenance	Level 3	NQF Level 03	15
Elective	10783	Join of aluminium by means of arc welding	Level 3	NQF Level 03	5
Elective	116714	Lead a team, plan, allocate and assess their work	Level 3	NQF Level 03	4
Elective	117877	Perform one-to-one training on the job	Level 3	NQF Level 03	4
Elective	116720	Show understanding of diversity in the workplace	Level 3	NQF Level 03	3

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED QUALIFICATION:

Further Education and Training Certificate: Yacht and Boat Building

SAQA QUAL ID	QUALIFICATION TITLE

78864	Further Education and Training Certificate: Yacht and Boat Building			
ORIGINATOR		**ORIGINATING PROVIDER**		
SGB Manufacturing and Assembly Processes				
QUALITY ASSURING BODY				
MERSETA - Manufacturing, Engineering and Related Services Education and Training Authority				
QUALIFICATION TYPE	**FIELD**		**SUBFIELD**	
Further Ed and Training Cert	Field 06 - Manufacturing, Engineering and Technology		Manufacturing and Assembly	
ABET BAND	**MINIMUM CREDITS**	**OLD NQF LEVEL**	**NEW NQF LEVEL**	**QUAL CLASS**
Undefined	146	Level 4	NQF Level 04	Regular-Unit Stds Based
REGISTRATION STATUS		**SAQA DECISION NUMBER**	**REGISTRATION START DATE**	**REGISTRATION END DATE**
Registered		SAQA 0486/10	2010-06-02	2013-06-02
LAST DATE FOR ENROLMENT		**LAST DATE FOR ACHIEVEMENT**		
2014-06-02		2017-06-02		

In all of the tables in this document, both the old and the new NQF Levels are shown. In the text (purpose statements, qualification rules, etc), any reference to NQF Levels are to the old levels unless specifically stated otherwise.

This qualification replaces:

Qual ID	**Qualification Title**	**Old NQF Level**	**New NQF Level**	**Min Credits**	**Replacement Status**
50560	Further Education and Training Certificate: Small Craft Construction	Level 4	NQF Level 04	169	Complete

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of this qualification is, to prepare qualifying learners for a career in boatbuilding, to provide an opportunity for people currently employed in the industry to achieve formal recognition for their accumulated knowledge and skills, and to enable them to develop a structured career path, as well as to facilitate the economic growth and development of the South African boat building industry.

Qualifying learners will have developed advanced boat building skills, knowledge and understanding, which include but are not limited to:

- Demonstrating an understanding of the basic principles of boat and yacht design.
- Demonstrating a practical understanding of the installation of marine systems.
- Demonstrating a thorough understanding of composite materials technology and advanced composite fabrication processes relevant to boat building.
- Discussing and describing the need for standards in boat building.
- Applying relevant standards to the different aspects of small craft construction and systems specification and installation.

Learners acquiring this qualification will have a thorough understanding of their role, and acquire the applied competencies to consistently and effectively execute their duties by contributing to the manufacturing process, and adhering to quality and safety requirements. The skills, knowledge and understanding demonstrated within this qualification are essential for social, economic and cultural transformation, and contribute to upliftment and economic growth within the manufacturing environment.

Rationale:

South Africa has a well-developed, albeit relatively small, boat building industry, which competes very favourably with the boat building sectors in other countries. South African built boats are highly regarded for their quality by both South African and foreign boat owners. Thus is testimony to the high degree of knowledge and skill prevalent in the South African boat building sector. These skills need to be formally transmitted to an increasing number of workers in the sector so that South Africa can remain at the forefront of world small craft construction and continue to attract foreign and local buyers.

An extensive review was undertaken of education and training programmes and qualifications in the boat building sector and this which resulted in the determination of a learning pathway for the sector. This qualification is the third in the pathway that addresses the full skills requirements of the boat building sector and will prepare qualifying learners for the broad range of activities that must be undertaken by the competent boat builder, whilst at the same time providing a sound base for further learning.

This qualification reflects the need and demand within the small craft construction sector for skilled employees. The qualification will enable learners to manufacture world-class products; it will improve professionalism in the sector and enhance the general quality of service delivery in the industry, thereby contributing positively to investor confidence and the international competitiveness of the South African small craft construction sector.

The qualification can be used to give recognition to experienced, but unqualified boat builders for the skills and knowledge they have acquired through the recognition of prior learning and credit accumulation. It also provides learners with opportunities for professional development and career advancement within the broader manufacturing environment.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

It is assumed that learners are already competent in:

- Communication and Mathematical Literacy at NQF Level 3.

Recognition of Prior Learning:

The structure of this unit standards-based qualification makes the Recognition of Prior Learning possible. This qualification may therefore be achieved in part or completely through the recognition of prior learning, which includes formal, informal and non-formal learning and work experience. The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the Recognition of Prior Learning option towards gaining a qualification.

If the learner is able to demonstrate competence in the knowledge, skills, values and attitudes implicit in this qualification the appropriate credits should be assigned to the learner. Recognition of Prior Learning will be done by means of Integrated Assessment as mentioned above.

This Recognition of Prior Learning may allow:

- Accelerated access to further learning at this or higher levels on the NQF.
- Gaining of credits towards a unit standard.
- Obtaining of this Qualification in part or in whole.

Access to the Qualification:

There is open access to the qualification for learners whose mobility on a boat will not be restricted due to any disabilities, as most training will take place on and in a small craft. However, it is preferable that learners first complete the National Certificate: Yacht and Boat Building, NQF Level 3 before accessing this qualification.

RECOGNISE PREVIOUS LEARNING?

Y

QUALIFICATION RULES

The Qualification consists of a Fundamental, a Core and an Elective Component.

To be awarded the Qualification learners are required to obtain a minimum of 156 credits as detailed below.

Fundamental Component:

The Fundamental Component consists of Unit Standards in:

- Mathematical Literacy at NQF Level 4 to the value of 16 credits.
- Communication at NQF Level 4 in a First South African Language to the value of 20 credits.
- Communication in a Second South African Language at NQF Level 3 to the value of 20 credits.

It is compulsory therefore for learners to do Communication in two different South African languages, one at NQF Level 4 and the other at NQF Level 3.

All Unit Standards in the Fundamental Component are compulsory.

Core Component:

This Core component covers competencies related to small craft construction practices, health, safety and environmental issues, tools and equipment, manufacturing processes and materials and standards. The unit standards provide the knowledge, values and skills that all learners require in order to engage in small craft construction practices. A high level of skill and understanding are necessary in activities as diverse as joinery, metalwork, composites fabrication, and electrical, mechanical and plumbing installation for the professional boat builder.

The Core Component consists of Unit Standards to the value of 75 credits all of which are compulsory.

Elective Component:

Learners are to choose unit standards from the Elective Component to the value of at least 15 credits to complete the qualification.

EXIT LEVEL OUTCOMES

Qualifying learners are able to:

1. Demonstrate an understanding of and apply the basic principles of boat and yacht design.

2. Demonstrate a practical understanding of the installation of marine electrical systems.

3. Demonstrate a thorough understanding and application of composite materials technology and advanced composite fabrication processes relevant to boat building.

4. Discuss and describe the need for standards in boat building.

5. Apply relevant standards to the different aspects of small craft construction and systems specification and installation.

Critical Cross-Field Outcomes:

The Critical Cross-Field Outcomes form an important part of the competencies required of a competent boat builder and are therefore integrated in a meaningful way into the unit standards making up the qualification. Details of how may be addressed are given in each unit standard.

ASSOCIATED ASSESSMENT CRITERIA

Associated Assessment Criteria for Exit Level Outcome 1:

- Displacement and stability calculations are undertaken during small craft design.
- Different sailing rig types are described and discussed in terms of their advantages and disadvantages and use.
- A general arrangement and interior layout drawing for a small craft is produced.

Associated Assessment Criteria for Exit Level Outcome 2:

- Guidelines for the installation of marine systems are followed.
- Maintenance activities are outlined and undertaken on marine systems.

Associated Assessment Criteria for Exit Level Outcome 3:

- A thorough understanding of composite materials and their interaction to form composite structures is demonstrated.
- Components are produced used advanced and specialised composite production processes.
- Hardware items are installed on composite panels according to recognised standards and industry best practice.

Associated Assessment Criteria for Exit Level Outcome 4:

- The role of international and local standards in boat design, construction and maintenance is described and discussed.
- Marine systems and structures are checked for compliance with relevant international and local standards.

Associated Assessment Criteria for Exit Level Outcome 5:

- Relevant national and international standards are applied to all design, production and maintenance activities undertaken.
- Implications of non-compliance with standards are discussed, for different aspects of yacht and boat building, and for the business of the boatyard.

Integrated Assessment:

- Assessment practices must be open, transparent, fair, valid, and reliable and ensure that no learner is disadvantaged in any way whatsoever, so that an integrated approach to assessment is incorporated into the qualification.
- Learning, teaching and assessment are inextricably interwoven. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the unit standards should be integrated.
- Assessment of Communication and Mathematical Literacy should be integrated as far as possible with other aspects and should use practical administration contexts wherever possible. A variety of methods must be used in assessment and tools and activities must be appropriate to the context in which the learner is working or will work. Where it is not possible to assess the learner in the workplace or on-the-job, simulations, case studies, role-plays and other similar techniques should be used to provide a context appropriate to the assessment.
- The term `Integrated Assessment` implies that theoretical and practical components should be assessed together. During integrated assessments, the assessor should make use of a range of formative and summative assessment tool methods and assess combinations of practical, applied, foundational and reflective competencies.
- Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience.
- Assessment should ensure that all specific outcomes, embedded knowledge and critical cross-field outcomes are evaluated in an integrated manner.

INTERNATIONAL COMPARABILITY

The South African boatbuilding qualifications have been developed to fit into the NQF system where a series of qualifications is developed at successive NQF Levels, each of which can be awarded to learners on completion, while full competence as a boatbuilder is only attained on completion of all the qualifications in the series. International practice, on the other hand, is that there is one large qualification encompassing the full range of competencies, skills and knowledge, which has to be completed for the person to be equipped as a competent boatbuilder. Learners internationally only receive the comprehensive qualification and not smaller, step-by step qualifications. This makes it difficult to compare the qualifications on a level by level basis with other qualifications from around the world.

While the qualified South African boat builder may ultimately have very similar skills, and a comparable level of knowledge to boatbuilders in different countries, the process of developing these is quite distinct in South Africa.

This qualification was compared with training offered in countries that are acknowledged leaders in the small boat-building industry i.e. countries whose industry supplies small craft to other countries. These countries are:

- USA.
- Malaysia.
- Turkey.
- Australia.
- New Zealand.
- UK.

The UK:

The United Kingdom is renowned for their boat building expertise and there are several national registered qualifications, however, it seems that many training providers still present their own traditional learning programs based on the learner's years of experience and specific manufacturer's needs. The UK is the only country that offers qualifications on consecutive 'levels' in a similar way to South Africa, but only does so at two levels, namely level 2 and level 3. In the UK there are very well established boatbuilding schools which offer the full range of training in a specialist practical environment. May of the programmes include theoretical examinations which students do online, while they have to demonstrate competence through a series of assignments managed and assessed at their boat building yard. The South African boat building qualifications are much more comprehensive.

New Zealand:

New Zealand offers qualifications at level 3 and level 4, but the qualifications are distinct and do not follow on from one another. By far the majority of the qualifications are at level 4, and the prospective boatbuilder would spend between three and five years accumulating the necessary credits, skills and experience to attain the level 4 qualification without first acquiring a level 2 or level 3 qualification along the way. In New Zealand there is a very well developed tradition of practical training being done in boatyards, and learners develop all their skill and experience in the workplace and attend polytechnics or universities for the theoretical content only.

In general the contents of the South African boat building qualifications, taking the level 2, 3 and 4 qualifications as a whole, compare well with the New Zealand boat building qualifications.

United States of America:

The American Boat and Yacht Council (ABYC) have a well developed professional certification process which covers the majority of the core boatbuilding skills. This series of South African boatbuilding qualifications (levels 2, 3 and 4) focuses on the same core knowledge and skills, and the successful learner should be well prepared for ABYC certification on completion of all three qualifications.

Turkey:

The boating industry in Turkey is well developed. A technical high school, Kurucasile, on the Black Sea Coast of Turkey, is devoted to boat building only. This school, in addition to modern techniques, teaches its students, elements and principles of traditional craftsmanship. A number of other schools and academic institutions also run diploma courses in boatbuilding, which include practical components being learned at large yards. All these diplomas are valid nationwide. These programmes and courses consist of all the skills and knowledge required by a boatbuilder and are not shorter certificate courses given to successful learners who have mastered only some of the skills and knowledge required. Diplomas issued by large universities (such as the naval architect diplomas issued by most technical universities) are internationally recognised.

Australia:

Australia has a well-established boat-building industry supported by well-defined units of study to be offered by training providers. Their learning programs in boat building do not seem to follow levels of complexity. It is very difficult to compare the South African individual boat building qualifications with those in Australia. However, it seems that once South African learners have completed the Further Education and Training Certificate: Boatbuilding and the preceding two qualifications at NQF Level 2 and NQF Level 3, they will be adequately equipped to compete with their Australian counterparts.

Malaysia:

Malaysia is an emerging boat building country. To date they have not developed a formal national qualification. They have however identified future training objectives and are in the process of developing learning programmes for the manufacture of fibreglass boats.

Africa in General:

Although many countries in Africa have displayed the capability to build boats of many shapes and sizes it still lacks the capability to build modern boats. No evidence was found of any boat building training being presented in sub-Saharan Africa. The South African qualifications could help to fill that gap on the continent by making these qualifications available to all those countries that might show an interest in these qualifications.

Conclusion:

Other countries all have a certain assumed level of basic education and do not attempt to combine teaching of Mathematics and Communication Fundamentals with the qualifications in the same way as the NQF in South Africa. While this is in response to a particular South African need, it further contributes to the local qualification being quite different in nature from any of its international counterparts.

The cumulative content of the South African qualifications (Levels 2, 3 and 4) is broader than would be required in Australia, Canada, New Zealand and the UK, but very similar to the recently developed ABYC qualifications in the USA. In the other countries, while the full scope of skills and knowledge are available as qualifications, students tend to specialise in more specific areas and so achieve a boat building qualification with a particular area of focus.

The South African qualifications offer learners a number of sequential shorter qualifications, while the other countries offer qualifications at the end of a longer, but possibly more narrowly focused period of learning.

Level 2:

In Level 2, learners receive an introduction to the working environment, workplace health and safety training, and entry level skills and boat building knowledge very similar to what they would receive in all the other countries, with the primary difference being that they receive a level 2 qualification at the end of it. The South African qualification includes Fundamentals in Mathematical Literacy and Communication which the others do not.

Level 3:

In Level 3, students build on the knowledge and skills acquired at level 2 in a very similar fashion to the other countries studied, with the main difference again being the awarding of a level 3 qualification upon completion, and the inclusion of further Mathematical Literacy and Communication

Fundamentals.

In terms of levels, the level 3 falls between the UK level 2 and level 3, and is similar to the New Zealand level 3, although in New Zealand no interim qualification is awarded.

Level 4:

At level 4 the learner hones his/her skills, and refines his/her knowledge of boatbuilding, and upon completion, the successful learner will have achieved an almost identical level of theoretical knowledge to his counterpart following the ABYC syllabus in the USA, but will achieve the qualification with slightly less experience. Likewise, the New Zealand, Australian and Canadian students will have more workplace experience and a slightly narrower theoretical basis, while the UK student will have less experience and a slightly narrower knowledge base, but much more intensive practical training.

As stated in the beginning, it is very difficult to compare unlike levels and systems across countries, and each system will naturally have its own benefits and drawbacks. The content of the South African qualification is as comprehensive as any other and broader than most, but the way of delivering the training and the assessment thereof are quite different.

ARTICULATION OPTIONS

Articulation:

This Qualification articulates with the following Qualifications:

Horizontal articulation:

- ID:36153; Further Education and Training Certificate: Polymer Composite Fabrication; NQF Level 4.
- ID:49092; Further Education and Training Certificate: Furniture Making: Wood; NQF Level 4.

Vertical articulation:

- ID: 22433; National Certificate: Manufacturing and Assembly; NQF Level 5.

MODERATION OPTIONS

- Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education and Training Quality Assurance Body (ETQA) or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Any institution offering learning that will enable the achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA`s policies and guidelines for assessment and moderation.

- Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

Criteria for the Registration of Assessors:

For an applicant to register as an assessor, the applicant needs:

- To be registered as an assessor with the relevant Education and Training Quality Assurance Body.
- A relevant tertiary qualification at one level higher than the level of the qualification and 12 months experience in the relevant field.

- Well-developed subject matter expertise within small craft construction.

NOTES

This qualification replaces qualification 50560, "Further Education and Training Certificate: Small Craft Construction", Level 4, 169 credits.

UNIT STANDARDS:

	ID	UNIT STANDARD TITLE	OLD LEVEL	NEW LEVEL	CREDITS
Core	376540	Demonstrate an understanding of boat design	Level 4	NQF Level 04	15
Core	376580	Demonstrate an understanding of boatbuilding standards	Level 4	NQF Level 04	20
Core	376582	Demonstrate an understanding of structural composites	Level 4	NQF Level 04	20
Core	376581	Install marine electrical systems	Level 4	NQF Level 04	20
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	NQF Level 03	5
Fundamental	119457	Interpret and use information from texts	Level 3	NQF Level 03	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	NQF Level 03	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	NQF Level 03	5
Fundamental	9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	Level 4	NQF Level 04	6
Fundamental	119462	Engage in sustained oral/signed communication and evaluate spoken/signed texts	Level 4	NQF Level 04	5
Fundamental	119469	Read/view, analyse and respond to a variety of texts	Level 4	NQF Level 04	5
Fundamental	9016	Represent analyse and calculate shape and motion in 2-and 3-dimensional space in different contexts	Level 4	NQF Level 04	4
Fundamental	119471	Use language and communication in occupational learning programmes	Level 4	NQF Level 04	5
Fundamental	7468	Use mathematics to investigate and monitor the financial aspects of personal, business, national and international issues	Level 4	NQF Level 04	6
Fundamental	119459	Write/present/sign for a wide range of contexts	Level 4	NQF Level 04	5
Elective	376545	Apply marine fairing and painting techniques	Level 4	NQF Level 04	15
Elective	263024	Plan and produce two dimensional (2D) Computer Aided Drawings (CAD)	Level 4	NQF Level 04	15
Elective	117166	Use CNC machinery in the furniture production process	Level 4	NQF Level 04	10

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION:

When qualifications are replaced, some (but not all) of their learning programmes are moved to the replacement qualifications. If a learning programme appears to be missing from here, please check the replaced qualification.

NONE

PROVIDERS CURRENTLY ACCREDITED TO OFFER THIS QUALIFICATION:

This information shows the current accreditations (i.e. those not past their accreditation end dates), and is the most complete record available to SAQA as of today. Some Quality Assuring Bodies have a lag in their recording systems for provider accreditation, in turn leading to a lag in notifying SAQA of all the providers that they have accredited to offer qualifications and unit standards, as well as any extensions to accreditation end dates. The relevant Quality Assuring Body should be notified if a record appears to be missing from here.

NONE

APPENDIX 3: CLASSROOM AND WORKSHOP OBSERVATION SCHEDULE

3 May 2012

Level 2

Theory classroom: Drawing class focused on line of offsets for a model boat.

09h55

Four learners working individually at drawing boards:

Learner A explains to Learner B how to mark off measurements.

Learner A: "The hardest part is drawing curves using a bent piece of plastic."

Learner B using a ruler.

Learner C : "The French curve does not really help us much so we use plastic." He explains to me they want to be pretty accurate because with a 1:10 scale, 1 millimetre on the drawing will be 1 centimetre on the model.

FRENCH CURVE

Page open on Lecturer A desk is p 126 of Merseta Learner Guide "Introduction to Boat Design 1"

PAGE FROM LEARNER GUIDE

MODEL SAMPLE ON LECTURER’S DESK

MODEL SAMPEL ON LECTURER’S DESK

NOTES ON THE BOARD

10h05

Tea Time (Learners leave)

I note down key learning points for this module from p 104 of the Merseta Learner guide.

- Explain what a yacht designer does
- Describe the boat design process
- Read a lines plan
- Name the 3 views shown in the lines plan
- Name the 4 sets of lines shown in the lines plan
- Explain why lines plans have a table of offsets
- Draw a rough sketch to show the outline of a boat
- Build a half model of a boat hull

-
- EXAMPLE OF MODEL

Lecturer A and I talk:

Lecturer A: “The POE needs evidence of what was done for example photos, oral or written test that will give us evidence of what was done. I do find it not like I want. The learners get an open book test and look up the answers in the text. It does not appeal so I create my own test so I know if they understand what has been taught. They are basically similar questions but with the given questions they don’t have to apply their mind to what has been taught. What they are being taught they must use in industry. If you try to memorise and apply…..*(lost note taking).*”

Lecturer A: “Going through the theory, especially fibreglass, mixing ratios is a problem. They have done it in theory, so when they do it in practical it was easier. When they started they had no idea of concepts *(VD note: ie first cover theory then practical application)”.*

Vanessa asks for clarity.

Lecturer A: “I gave them calculating quantities, size of fibreglass and costing sheet for layup *(VD note costing is information outside of the qualification)*. For me it was costing and they battled with it.”

Vanessa: “Why did you choose it?”

Lecturer A: “I will see if they took in what I taught because it involves maths and gives no idea of real life product costs and possibly prevents them from wastage and being cost effective. There were very different results from students eg the product should have cost R1000 but one student came out at about R40 000.

Lecturer A: “I have drawn up a couple of tests. There is a gap between the POE and real assessment. Before the new curriculum, I drew up my own tests.”

Vanessa asks for clarity,

Lecturer A: “The shift happened when there wasn’t set assessment questions, only learning material. Going a bit away from curriculum in terms of models, we show them basic joints but incorporated into the model.”

VD note: He diverts away from what feels like uncomfortable territory to him- curriculum.

Lecturer A: “The students go home with something for example a table with five joints and a product to take with them. It is the same for the clock with fibreglass.

Lecturer A goes through the costing exercise with VD. *(Note: this is important to him)*

Lecturer A: “I try and incorporate this exercise into the practical fibreglass work *(referring to costing*).”

Lecturer A explains resin catalyst mixes and solutions *(Note: he is trying to teach VD).*

Lecturer A: “I will show them why they shouldn’t add more catalyst when doing the practical eg fire hazard and excess fumes. I follow the curriculum but I put in extra demonstrations eg I cut through a model to show the waterline and butt lines. They can see instead of just reading notes. There is nothing wrong in the notes but it is good to speak from your own experience… why things have gone wrong.” *(VD note: again a focus on what and GO WRONG)*

Vanessa asks Lecturer A about his background history and how he came to be a boat building lecturer:

- Finished school and joined the upholstery trade but it was not for him
- He took up joinery and did his apprenticeship at GHB Joinery.
- He qualified and was employed as a shop fitter. They were strict on quality – “what I found I wanted to do things with a passion”
- Did site fixing, manufacture and installation
- Then looked at other woodworking options and this led him to boat building
- He worked for Andy’s Marine building small speed boats, then Sen Marine building aluminium yachts and then seven years at Southern Wind Shipyard. “In that time I did lots of corian work. Southern Wind used to outsource to Unique Fabrications.”
- Another passion was being a supervisor in the carpentry finishing department
- Then he moved on to fitting of teak decks and the opportunity arose for me to teach at False Bay College.
- He has not regrets.

10h55

Learners return to the classroom.

Lecturer A: holds up a half hull to explain design waterline. “If weight goes in, it sits deeper in the water. What are the vertical lines?”

Learner D: “Buttocks”

Lecturer A: then uses the half model cut into sections to illustrate buttocks. He picks up another model. “What is the view?”

Learner B: “Body plan view”

BODY PLAN VIEW

Lecturer A: then explains diagonal lines. “If you got a drawing at 1:10 and 1:5, which model will be bigger?”

Learner B: “1 – 10” *(wrong answer)*

Lecturer A: “Why do you say that?”

Learner B: Replies (inaudible)

Lecturer A: draws on board 1:10

Learner B: “Oh ja, you mean the model, yes the product will be bigger.”

Lecturer A: Explains ratio and model size on the board. “I am thinking of giving you one is to five to give you this size.” He holds up various models for comparison. Holds up a cardboard model to show waterlines. “I have gone a step further, I have taken all of the waterlines as on your drawing Each represents different waterlines. I have taken superwood and cut each size. When we cut models we cut from these then we build it up.”

(VD note: the learners don't really seem to be getting the ratio and model explanation. Lecturer A is trying to make theory practice link but it is tenuous)

Lecturer A: "We don't get super wood in 26 mills so in the workshop we will have to start laminating.

(All the learners go back to their drawings. The pace of the class is very uneven in terms of the drawing task)

DRAWING TASK

Lecturer A: explains that the plastic strip is called a baton in lofting. "Ok guys now we get to the body plan stage where you draw the body plan."

Learners help each other with their drawings and Lecturer leaves them.

Lecturer A interrupts to explain how to do the top view. "Look at your little drawing and ignore the bottom section. You need buttock spacing and thickness of keel." He explains on the board briefly. "Any questions?" He goes to individual desks to help and explain.

(VD note Learner B is still busy with the first exercise and has not moved on to the top view)

SLOWER PACED LEARNER

Lecturer A: "Did I tell you to measure from…..? Remember I said to you yesterday they are extra points."

(VD note: first reference to any previous explanation)

Learners A, C and D gather around Lecturer A explaining and Learner B continues solo with the first exercise.

LEARNER B STILL ON FIRST TASK

(VD Note: 2 learners are working faster and dictating the pace of instruction. Pace seems to be assumed very tacitly and it is hard to pick up markers. The slower 2 learners engage with the new information and then go back to the first exercise.)

Learner C to Learner D: "Why don't you grind down the edge?" *(of plastic being used to draw curve)*.

Learner D to Learner C: "Cos then you wont have a flat surface."

(Learners C and D work together and the other two individually)

Learner D uses piece of wood instead of plastic to draw a curve. *(VD note he is the only one who did this and he seems to be the slowest)*

Two learners work on one drawing. One hold the plastic to bend it to the curve while the other one draws the line. A learner who is not part of the class comes in to check on the slower student working alone and gives positive comment.

TWO LEARNERS WORK ON ONE DRAWING

Programme Manager comes in to look at what everyone is going including VD. “ I can’t see a thing my spectacles are inside.” He explains to the class this is all now done by computeR, but you need to know the manual method.

Programme Manager to VD: “These are part of Department of Manpower’s lofting exercises.”

Learner C to himself: Holds up drawing “I think its beautiful.”

Programme Manager to VD: I want to get them drawing it is not in the curriculum, it is a unit standard, we need drawing basics.” He refers back to a debate with a materials developer on the definition of a centre line in CAD.

Learner B to Learner C: “This is where I made a botch up. You understand?”

Learner C to Learner B: “No”. Learner B explains.

Programme Manager to VD (referring to Lecturer A): “They are not teachers so their time keeping is not good. Lecturer A is getting better with this group. He does not always get through things.”

Lecturer A returns to classroom and helps one learner.

Programme Manger to class: “You will find offsets are not always accurate. You will use backing to fair it out to get a natural curve.”

EXAMPLE OF TABLE OF OFFSETS

10h40

Stop observation

(VD note: Programme Manger taking my attention away from observation. Power dynamics at play. Lecturer A invites me back because the learners work so hard. The Learners are less phased by my presence than the Lecturer A and Programme Manager.)

22 March 2012

Notes to meeting with Level 4 learner completing theory component

Currently busy self studying the maths literature component.

Learner A: No relevance to boat building as it is below matric level. When they did the boat design section the lecturer supplemented the Merseta developed learning material. It compliments the Westlawn curriculum on stability and hydrodynamics. He does not apply design theory it in the workplace. It helps because you get to know what happens if you move an engine and then need to change the trim of the boat. Normally a designer works it out.

Learner A: Knows how to improvise when running into problems. You always run into problems in boat building. The customer makes changes and this impacts on the design eg re-design the engine mount. Eg X suddenly put generators in and they were mounted higher than they were going to be. The higher you are in the factory the more you make decisions.

Learner A: The rigging theory section is not relevant to building, if you follow the plans. South Africa trains staff off the street, so staff don't know about sailing. It is a problem because if they run into problems they improvise and it might affect the end product. Eg he knows you can't use this or that because of a sea water environment.

Learner A: there are a lot of elements in boats. Some things are more important eg where the mast gets attached to the boat. Eg in my first year in work placement – in a boat you have main bulkheads so that must be the strongest part and the laminator skipped half the layers so if you actually knew (the theory) you shouldn't do that. If the guy had known about boat building he would have known the most important part.

Learner A: "little things add up". Also installing equipment and final systems are more complicated on a boat with moisture. There are small things boating people do differently. Running into problems you get stuff breaking on boats, like electrical stuff so you spend more time sealing things. There are small things like not sealing hatches. You have to finish the job and the supervisor is not always around.

Level 2 workshop drop in observation on the same day

Leaner A planeing block of wood.

Learner B putting masking tape on the keel of the March Cat boat

Learner C sanding a table leg.

Learner A periodically stops and asks the lecturer. Lecturer A tells him he can cut through but he is not sure of the diameter. He needs to consult Lecturer B. Lecturer A and B and 3 learners gather to watch the discussion. Lecturer A and B agree on a design and what needs to be done. Lecturer A tell Learner A to cut through and glue, cut on the circular saw and butt joint with clamps. Lecturer A says “I will assist you with that one now.”

Learner B working on the keel, tidies the work bench, walks over to chess boards and feels the spray finish.

Learner C finishes sanding the table, puts it on its end and checks alignment. Also moves over to feel the spray finish of the chess boards with Learner B. Both discuss and closely examine detail and finish. Learner C continues sanding.

APPENDIX 4: LEARNING MATERIAL ANALYSIS

Level 2 Boat Design Learner Guide

Unit	Learning Activity	Formative Assessment	Summative assessment
1. Classification of boats and hulls	1. An introduction to boat design 2. Different propulsion systems 3. Boats for every purpose 4. Boat parts 5. Hull forms 6. Hull types 7. Getting familiar with design terminology 8. How do boats float?	1. Can I identify hull types? 2. Can I name the part and recognise the terms?	
2. Materials and methods for building	9. The many materials 10. Wood as a boat building material 11. Metal as a boat building material 12. Ferrocement as a boat building material 13. Composite materials in boat building 14. The construction process 15. Once of vs production process 16. What is the different between a male and female mould? 17. Building to standard	3. Can I identify the advantage and disadvantages of different boat building materials?	
4. Basic boat design	18. Who is the naval architect? 19. The design spiral 20. The design process 21. Our boat design or plans 22. What is a lines plan?		

	23. How do I read technical drawings and plans 24. Practice time! Draw objects from different views 25. Learning to read maps 26. Practice time! Can you read the lines plan? 27. Getting back to the lines plan 28. How is a lines plan drawn 29. Practice time! Drawing the outline of a boat 30. What do I need to know about half hull models? 31. How do I construct a half hull model? 32. Practice time! Can I construct a half hull model?	5. Can I read and interpret the lines plan?	
			1. What is the difference between production boat building and custom boat building? What kind of boat building does your yard do? 2. What is the difference between a female and a male mould? What types of moulds does

			your boat yard use? 3. Find an example of a boat building standard that your boat yard uses when building boats. Explain in plain words what the standard says. 4. List 4 boat building materials. For each material that you list, name 2 advantages of that material. For each material that you list, name 2 disadvantages of the material. 5. Look at the names of different parts of a boat provided below. Look at the figure on the next page. Use the names provided to lable each of the parts on the figure. 6. Look at the different positions on a boat provided below. Look at the plan view of the boat in the

			figure below. Use the names provided to label each o fhte positions on the boat. 7. What does each of the terms below mean? Length overall, LWL, Beam, Draft, Freeboard. 8. Look at the 3 boats bleow. Write down the name of each of the boat hulls. 9. What is the difference between a displacement hull and a planning hull? Pick a boat in your yard. Identify whether it is a displacement of a planning hull. 10. Use the space provided below to draw the following hull shapes: A v botton, a round bottom and a flat bottom. 11. What is a lines plan? 12. Who draws a lines plan? List 3 resources that

			they use to draw a lines plan. 13. Look at the example of a lines plan shown. What are the names of the 3 views shown I the lines plan? What does each of these views show? What are the names of the 4 sets of lines shown in the lines plan? What does each of these sets of lines tell us about the boat hull? 14. What is the table off sets? 15. What are the main steps that you must follow when building a half hull model?

Level 3 Boat Design

Unit	Learning Activity	Formative Assessment	Summative assessment
1. Lines plans and lofting	1. Revisiting the lines plan 2. Basic hull measurement terms 3. What is lofting 4. Why loft? 5. What do I need in plce to loft? 6. Drawing out and lofting the stations 7. Practice time! Loft a station	1. Can I interpret the lines plan? 2. Can I loft?	

	8. Part 2 – Marking out the area and seating up the jig 9. Practice time! Mark out the centre line and stations and set up the strong back		
2. Boat design principles	10. How do boats float? The concept of buoyancy 11. The centre of buoyancy 12. Displacement experiments 13. Displacement 14. Weight and the centre of gravity 15. Volume – a very basic introduction 16. Density 17. Estimating a boats weight 18. The relationship between CB and CG		
3. Calculating areas and volumes	19. An introduction to area calculations 20. Calculating the area of regular shapes 21. Calculating the area of triangles 22. Calculating the area of circles 23. Calculating the area of irregular shapes 24. Calculating the volume of a regular shape 25. An introduction to hydrostatic calculations 26. Simpsons Rule 27. Practice time! Applying Simpsons rule 28. The trapezoidal rule 29. Practice time! Applying the trapezoidal rule 30. Mass per cm of immersion 31. Getting back to displacement 32. Calculating the displacement volume of a boat hull 33. Practice time! Calculating displacement volume	3. Can I complete area calculations? 4. Can I complete volume calculations? 5. Can I apply Simpsons Rule and the Trapezoidal rule?	
4. Rudder design and principles	34. What is a rudder? 35. Parts of a rudder 36. Types of rudder		

	37. Rudder design considerations 38. Rudder installation considerations	5. Do I know about different types of rudders? 6. Can I classify the rudder on our boat?	
			1. There are two common sets of measurements provided in the table of offsets. Where is each of these sets of measurements taken from? 2. When numbering stations on a lines plan, what number is most commonly used by yacht designers for the bow station? 3. What is the common interval of the boats below – you can assume that the designer used 10 stations when drawing a lines plan: A small power boats with a load waterline of 9m, A sailing yacht with a load waterline of 65m. 4. Draw a basic profile outline of a boat in your yard. On your rough sketch label the following terminology and provide actual measurements: LOA, LWL, Beam, Sheer, Draft, Freeboard. 5. What is buoyancy? 6. What does the Archimedes Principle tell us? 7. What does it mean to "loft" a boat? 8. List the steps that you need to follow

			when lofting the stations to full size from a lines plan. 9. Write down three tips to bear in mind when preparing the lofting area. 10. What is an”area”? Why is it important for yeacht designers and boat builders to be able to do area calculations? 11. Look at the figure below. It shows the sail plan of a yacht. The foot of the headsails (the jib) is 2.68m long and the leech is 6.34m long. The Mainsail has a 3.40m foot and a 9.55m luff. Calculate the area of the jib, calculate the area of the mainsail, what is the total sail area? 12. Look at the figure below. It shows the waterplane area of a boat with a DWL of 18m. Complete the following calculations for this figure: use the Simpsons Rule to calculate the area of the waterplane; Use the Trapezoidal Rule to calculate the waterplane; Compare the area results that you calculated using Simpsons Role and the Trapezoidal Rule and show the difference between the results.

			13. What is a "volume"? Why is it important for yacht designers to be able to do volume calculations? 14. Look at the figure below – it shows the internal dimensions of a fresh water drinking tank on a boat. What is the internal volume of the tank? How many liters of water will the tank be able to hold (if it is completely filled)? 15. Look at the picture below – it is a foam mattress for one of the berths on a new boat. The mattress has the following dimension: length 1.905m, breadth 0.7366m, thickness 0.127m. What is the volume of the foam mattress? Assume that the foam weighs 105.72 kg/m. How much will the mattress weigh? 16. A yacht designer has done his weight study for a boat that will be used in South Africa's coastal waters. The boats current weight estimate id 27 500kg. What is the required underbody volume of this boat for it to be able to float?

			17. Look at the pictures of the different rudders provided. Identify the rudder show in each picture. 18. Draw the outline of a rudder that is in your boat yard and label all the different parts on the rudder you have drawn. 19. You learnt about 4 main rudder design considerations. List them. Calculate the ideal rudder size for a fin keel yacht with the following measurements: Waterline length 15.75m, draft 3.60m.

Level 4 Boat Design

Unit	Learning Activity	Formative Assessment	Summative assessment
1. Advanced design principles	1. Revision of key concepts in hydrostatics 2. Revision of area and volume 3. Revision of how to establish a boats under body volume 4. An introduction to hydrostatics calculations 5. Simpsons Rule 6. The Trapezoidal Rule 7. Applying Simpsons Rule and the Trapezoidal Rule to find the areas of the water plane 8. Looking at displacement 9. Calculating the displacement volume of a boat hull 10. Displacement weight 11. Finding the areas of curved sections	1. Calculating displacement volume 2. Finding displacement weight of a hull with curved sections	

	12. The relationship between CB and CG 13. Definitions of stability 14. The measure of stability		
2. External design components	15. Gaff rigs 16. Bermuda rigs 17. Rigging and different types of sailboats 18. Comparison in efficiency of various rigs 19. Standards for handrails and re-boarding systems	3. Standards for handrails and re-boarding (with reference to ISO standards)	
3. Internal design components	20. Interior design features		1. Explain the importance of displacement calculations in boat building. In your anser describe what could happen if displacement is calculated incorrectly. 2. Write about a page of notes in which you discuss stability of a sailing boat. Make sure you describe the following: what stability is, how stability is measured (illustrated with a diagram), what affects stability, the consequences of insufficient stability. 3. Describe the rig configurations of 4 different types of sailing boats. Make sure you cover the features and advantages of the 2 different kinds of rigs. Your descriptions should cover the key features of small craft rig design and how these features

			affect sailing performance. 4. With reference to the ISO standards provided in your learner guide, make a list of the key requirements that will need to be met regarding the installation of hand rails and re-boarding systems.