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EDUCATIONAL STRATEGIES TO FACILITATE GRADUATE ATTRIBUTES OF FOOD SCIENCE AND TECHNOLOGY STUDENTS

By

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Thesis submitted in fulfilment of the requirements for the degree

Philosophiae Doctor (Educationis)
in the
Faculty of Education
at the
University of Johannesburg

Supervisor
Prof C.M. Fourie

Co-Supervisor
Prof C.P.H. Myburgh

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- **Word count:** 88,663
- **Character count:** 553,458
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- **Submission ID:** 1135442644

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**UNIVERSITY OF JOHANNESBURG**

EDUCATIONAL STRATEGIES TO FACILITATE GRADUATE ATTRIBUTES OF FOOD SCIENCE AND TECHNOLOGY STUDENTS

By

Dja Justine Metcalfe

This is a submission in fulfillment of the requirements for the degree.

PhD in Science (Education) in the Faculty of Education at the University of Johannesburg.

Supervisor:

Prof. G. M. Fraser

Co-Supervisor:

Prof. P. M. Walburg

May 2013

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DEDICATION

It is an honour to dedicate this thesis to Prof Amanda Minnaar (1962 – 2015), who acted as a co-supervisor and mentor in the initial stages of this study. Amanda, thank you for believing in me. Your memory continued to inspire me throughout the remainder of the doctoral journey.
ACKNOWLEDGEMENTS

I express thanks and acknowledge the many special and supportive people who have encouraged and walked beside me through my journey of self-discovery and self-realisation. This study would not have been possible without the patience and encouragement of friends, colleagues and former students who believed in me.

My gratitude to my family, especially my late mother, Isabel Jean Bunce (1939 – 2010) and father Jonathan Metcalfe, who never had the prospect of higher education, but made sure the opportunity was available to me. Your support and encouragement meant the world to me. I must also acknowledge the support of my sisters, Sharon Morag Abbott and Michelle Alexandra Sidwell who eventually gave up asking me when I was going to complete my studies.

My appreciation and admiration must be expressed for this study’s supervisor, Prof C. M. Fourie, and co-supervisor, Prof C. P. H. Myburgh. Without your steadfast support and guidance, it is doubtful that this thesis would have been completed. Prof Fourie, thank you for never giving up on me. Your unwavering backing has meant so much to me and has been a beacon of light in dark days when you reinvigorated me and made me believe in myself. Prof Myburgh, thank you for stepping up to the challenge of acting as my co-supervisor at such a late stage. It has been a pleasure to work with you and to be guided by your critical feedback.

Lastly and most importantly, I must acknowledge the unwavering support of Mike Muller, who met me shortly after I had started the doctoral journey. Your unfailing encouragement, love and many sacrifices have made this journey possible. I have no words that can express my love and gratitude to you. I am looking forward to our retirement, being able to enjoy our beautiful home and to spend time travelling with you.
ABSTRACT

There is a growing awareness of the responsibility of higher education to develop graduates who meet the expectations of the community they serve and who are effective from ‘day one’ in the workplace. However, South African employers of newly graduated food scientists and technologists often comment that higher education is not fulfilling this mandate. Therefore, the purpose of this study was to firstly identify the graduate capabilities that South African food scientists and technologists must demonstrate when they first take up employment to meet the expectations of societal stakeholders. Graduate capabilities in the context of this study are the complex combination of generic graduate attributes including employability skills and graduateness, personal attributes and the discipline-specific knowledge, skills and competencies that are core to the effectiveness of a newly graduated food scientist and technologist. Once the required graduate capabilities were known, the purpose of this study was to develop educational strategies aimed at the facilitation of the academic staff teaching food science and technology students.

This study comprised two phases. The first phase was a situation analysis that made use of a questionnaire, deployed as a web-based survey, that was developed based on available literature and confirmed using a focus group. The survey tool collected the perceptions of participants including employed food scientists and technologists, relevant government representatives, academic staff teaching food science and technology students and employers within the South African food, beverage and allied industries. The data collected through the survey was analysed as ordinal data using descriptive analysis largely based on frequencies. The criteria of 80 percent and above of ‘high importance’ responses from the participants was used to identify an essential graduate capability of newly graduated food scientists and technologists. The situation analysis identified that South African food science and food technology graduates must display similar graduate capabilities despite their varied educational backgrounds. The food science and technology-specific knowledge, skills and competencies perceived as essential to South African food science and technologists corresponded with those captured by the globally available food science and technology education guidelines, the ‘Core Competencies for Food Science’, of the
Institute of Food Technologists. However, the generic graduate attributes and personal attributes identified as essential to South African food scientists and technologists were more specific than those captured by the educational guidelines of the Institute of Food Technologists but were in line with available literature pertaining to the generic graduate attributes, employability skills, graduateness and desirable personal attributes that are increasingly expected from all graduates of higher education.

The second phase of this study was based on the outcome of the situation analysis. Several challenges were articulated based on the findings that needed to be addressed to achieve newly graduated food scientists and technologists that demonstrated similar graduate capabilities aligned with the empirical findings of this study. To this end, a conceptual framework was developed to guide a facilitation process aimed at the academic staff teaching food science and technology students. The purpose of the facilitation process was to empower the academic staff to address the identified challenges within the context of the existing food science and technology educational programmes by enhancing their teaching, learning and assessment practices. In turn, the facilitated academic staff will be able to support future food science and technology students to attain the required graduate capabilities expected by societal stakeholders.

This study focussed on the role of higher education to meet the needs of societal stakeholders and draws attention to educational strategies that can empower academic staff to develop and enhance their teaching, learning and assessment practices to support students to attain the graduate capabilities required and expected by societal stakeholders during undergraduate studies. Therefore, this study may be of value to the higher education sector in general. Predicting the changing needs of employers over time is a challenge to higher education institutions and is also addressed in this study.

Keywords: higher education; food science and technology; graduate capabilities; generic graduate attributes; employability skills; graduateness; personal attributes, education strategies.
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CHAPTER ONE: ORIENTATION TO AND CONTEXT OF THE STUDY

You have brains in your head.
You have feet in your shoes.
You can steer yourself any direction you choose.
You’re on your own. And you know what you know. And YOU are the guy who’ll decide where to go (Dr Seuss, 1990).

1.1 INTRODUCTION AND BACKGROUND TO THE STUDY

It is said that “every new beginning comes from some other beginnings’ end” (Seneca, ca. 4 BC – 65 AD). Leaving high school is no exception as it unlocks many possibilities and choices. One popular choice for school leavers is to prepare for the future by entering higher education. Their motivation for this choice is varied; reasons for school leavers themselves could be to increase the probability of meaningful employment, a successful career and a higher earning potential (Altbeker & Storme, 2013:1; Guthrie & Fernandez, 2004:276). Other reasons may be driven by the school leavers’ interest in a specific discipline or area of study. Many may simply want the experience of attending a higher education institution (Lowden, Hall, Elliot & Lewin, 2011:iii). No matter what the motivation, in the end, higher education graduates must meet the expectations and demands of societal stakeholders such as government, professional bodies, and employers (Adam, 2009:84; Halliday, 2004:279; Harwood, 2010:417; Mouzakitis, 2010:3914). However, these expectations and demands are often diverse and may be difficult to define (Adeyemo, Ogunleye, Oke & Adenle, 2010:102). Additionally, the expectations of the graduates themselves must be met, provided these expectations are realistic (Archer & Davidson, 2008:16; Chetty, 2012:5). The graduate should, above all, be prepared to face a future which is unknown and difficult to anticipate (Barnett, 2004:247). It therefore follows that graduates ought to be adaptable to meet the requirements of the progressive and rapidly changing workplace (Andrews & Higson, 2008:411; Barnett, 2004:247; Guthrie & Fernandez, 2004:278). This implies life-long learning, understood in terms of human qualities rather than only skills, competencies, expertise or knowledge (Barnett, 2004:247).

Chapter One introduces and provides the background, context and rationale for conducting this study. The research design and methodology implemented to achieve
the overall aim of the study are also introduced. An overview of the structure of this chapter is provided in Figure 1.1.

![Figure 1.1: Overview and structure: Chapter One](image)

1.2 IDENTIFYING THE RESEARCH RATIONALE

1.2.1 Contemporary perspectives on the role of higher education

It is a well-known fact that the role of higher education in the 21st century is exceptionally complex (Andrews & Higson, 2008:412; Barnett, 2004:250). Higher education is ever-changing to realise the expectations of the communities it serves, the political and economic environment in which it operates, its societal obligations, and its own values, mission and vision (Andrews & Higson, 2008:411; Cai, 2012:2; Hazelkorn, 2013:2). However, due to the pace at which new knowledge is generated, it is sometimes difficult to ensure that academic or discipline-specific knowledge is up-to-date, keeping in mind that technology-based qualifications are proposed to become outdated within a few years (Bull, 2010:16; Guthrie & Fernandez, 2004:278).
Similarly, knowledge acquired through professional qualifications is constantly evolving, and graduates must be capable of life-long learning to keep up-to-date and to upskill and reskill where necessary (Bull, 2010:14; Coetzee & Potgieter, 2012:2; Confederation of British Industry (CBI) & Universities United Kingdom (UUK), 2009:5). Under these circumstances, higher education needs to prepare graduates for an unpredictable future (Barnett, 2004:247).

Apart from the necessity for graduates to embark on life-long learning to remain current, worldwide societal stakeholders are increasingly voicing their requirements for graduates; they are expected not only to have essential academic knowledge and skills, but to be competent in the workplace (Archer & Chetty, 2013:135; Griesel & Parker, 2009:6; Halliday, 2004:579; Harwood, 2010:421), to be adaptable (Barnett, 2004:247), and to be able to move effortlessly between workplaces (Andrews & Higson, 2008:411). As such, the higher education environment is tasked with developing graduates holistically, rather than only through discipline-specific knowledge, skills and competencies, to meet the demands and requirements of societal stakeholders (Barnett, 2009:1; Cai, 2012:1; Litchfield, Frawley & Nettleton, 2010:519; SA DHET, 2011:3). However, traditionally, higher education tends to focus more on research and the ‘disciplinary body-of-knowledge and profession-based understandings’ required of graduates (Litchfield & Nettleton, 2008:553), rather than teaching and learning strategies, and employability and work-readiness skills required by employers (Glover, Law & Youngman, 2002:303; Litchfield et al., 2010:519; McInnis, 2005:81; SA CHE, 2011:1; Steur, Jansen & Hofman, 2012:864).

Thus, the wider community, including government, employers, students and parents, may have expectations that differ from the opinions of higher education. This could result in tension between higher education and community stakeholders (Cai, 2012:2; Guri-Rosenblit, Sebkova & Teichler, 2007:2; Høstaker & Vabøhigher, 2005:232; SA DOE, 1997b:83). Correspondingly, the disparity between the views of higher education versus the needs and expectations of community stakeholders must be addressed to the advantage of both. Mouzakitis (2010:3914) suggests that better alignment between the expectations of higher education and societal stakeholders may be achieved by shifting educational planning to new forms of instructional content and delivery that is supported by educational policies and strategies based
on a ‘market needs assessment’. In support, Allais (2017:147) suggests that the relationship between higher education and the needs of the community must be continually monitored through tracing graduates into employment. Employer requirements and satisfaction studies should be conducted to highlight societal stakeholders’ changing needs and ensure that graduates meet these expectations.

1.2.1.1 Skills development in higher education

Societal stakeholders continue to voice their concerns that graduates are not fully meeting their needs and expectations (Cai, 2012:1; Deželan & Pavlin, 2014:363; Litchfield et al., 2010:519; SA DHET, 2011:3). The skills and attributes of ‘work ready’ graduates have been described with various terms, often based on policies specific to a region or country, and sometimes used interchangeably. Such terms include generic skills (Pool & Sewell, 2007:218; Steur et al., 2012:862), soft skills (Andrews & Higson, 2008:413; Bancino & Zevalkink, 2007:20), career preparedness skills (Bohlscheid & Clark, 2012:8), graduate attributes (Griesel & Parker, 2009:5; Oliver, 2011:7), graduate capabilities (Barnett & Coate, 2005:95; Coetzee, 2014:80; Daniels & Brooker, 2014:66; Oliver, 2011:7), core skills (Barnett & Coate, 2005:126; Glover et al., 2002:298), generic transferable skills (Bennett, Dunne & Carré, 2000:32; Guilbert, Bernaud, Gouvernet & Rossier, 2016:71; Hinchliffe & Jolly, 2011:563; Hooker & Whistance, 2016:156), day-one skills (Welsh, Jones, May, Nunn, Whittlestone & Pead, 2009:771), and 21st-century skills (Berg, Osher, Same, Nolan, Benson & Jacobs, 2017:23; Collet, Hine & du Plessis, 2015:546; National Research Council, 2012:1; Trilling & Fadel, 2009:45), among others.

The term ‘generic graduate attributes’ is used in this study to indicate the generic skills that can be transferred to many areas of life and that can be expected of all graduates by society and employers (Bohlscheid & Clark, 2012:8; Lowden et al., 2011:vi; Oliver, 2011:8; Steur et al., 2012:862). Generic graduate attributes include, but are not restricted to, oral and written communication, teamwork, problem identification and solving, numeracy, creativity and computer literacy, to name a few (Bohlscheid & Clark, 2012:8; Lowden et al., 2011:vi; Oliver, 2011:8; Steur et al., 2012:862).
Lowden et al. (2011:4) recognise that graduate employability is promoted by the generic graduate attributes advocated as important to prepare graduates for their future roles (Andrews & Higson, 2008:413; Archer & Davidson, 2008; Griesel & Parker, 2009:5; Litchfield et al., 2010:521, Lowden et al., 2011:v). However, this view is contested by Barnett (2004:247) who articulates that “the idea of skills, even generic skills, is a cul-de-sac” and advises that the graduate must be developed holistically; a view supported by Yorke (2006:8) and Bridgstock (2009:32). The holistic identity of a graduate is pliable rather than static and moves beyond generic graduate attributes that can be ticked off a list (Hinchcliffe & Jolly, 2011:564). In support of this view, several authors argue that the generic nature of skills is a misconception. They suggest that the students’ skills and abilities should meet the defined needs of a profession or vocation (Barnett & Coates, 2005:54; Flynn, Wahnström, Popa & Quintas, 2013:246; Holmes, 2013:1046; Lowden et al., 2011:vi; Oliver, 2011:2). As such, graduate attributes can be viewed as falling into two categories – firstly, the broader, generic attributes common to all graduates of higher education, and secondly, the combination of generic and unique discipline-specific knowledge, skills, competencies and values, referred to as ‘combined graduate attributes’ in South Africa (Griesel & Parker, 2009:5), and as ‘graduate capabilities’ within Australia (Oliver, 2011:7).

The term ‘graduate capabilities’ was used in this study to describe the ‘combined graduate attributes’ that graduates of higher education must display. Graduate capabilities are complex and multifaceted and need to meet an array of expectations, such as workplace readiness and employability versus continuing with postgraduate studies. Furthermore, the graduate capabilities among graduates are influenced not only by the higher education institution’s own values and beliefs, but also by the political climate and the community, including employers and professional bodies and the specific requirements of the discipline, vocation or profession (Barrie, 2006:216; Flynn et al., 2013:247; Tran, 2016:58).

1.2.2 Food science and technology education

This study was conducted in the context of food science and technology education (Bohlscheid & Clarke, 2012:8; Dench, Hillage, Reilly & Kodz, 2000:9; Floros,
Newsome, Fisher, Barbosa-Cánovas, Chen, Dunne, German, Hall, Heldman, Karwe, Knabel, Labuza, Lund, Newell-McGloughlin, Robinson, Sebranek, Shewfelt, Tracy, Weaver & Zeigler, 2010:572; Flynn et al., 2013:247; Institute of Food Technologists (IFT), 2011:6). Globally, food science and technology have a crucial role in terms of food safety, quality and availability (Brennan, 2015:1; Campbell-Platt, 2018:1; Floros et al., 2010:572; Kroger, 2010:437). In Africa, food science and technology are identified as equally important, especially with respect to food product manufacturing to meet the demand for sufficient healthy and nutritious foods (Minnaar, Taylor, Haggblade, Kabasa & Ojijo, 2017:247; Pereira, 2014:2).

Worldwide, the demand for qualified food scientists and technologists outstrips the number of available candidates (LeGrand, Yamashita, Trexler, Vu & Young, 2017:118; McGrath, 2008:23). This is also the case in South Africa where ‘food and beverage scientists’ are highlighted as a scarce skill as the annual number of food science and technology graduates needed by the economy is reported to exceed the number of graduating students (Reddy, Rogan, Mncwango & Chabane, 2017:71; SA DHET, 2018:9). This lack of necessary skills in South Africa is a problem for the agricultural sector and the food and allied processing industry in meeting the country’s food requirements (Food and Agricultural Organisation (FAO), 2018:1; SA DAFF, 2012:135). A similar problem is faced in Australia (Australian Workforce and Productivity Agency, 2013:6). However, skills shortages, in general, are outside the scope of this study.

Employers and other societal stakeholders often comment that, in general, graduates do not fully meet their expectations and requirements (Deželan, Laker & Pavlin, 2016:110; Griesel & Parker, 2009:5; Samadi, 2013:17). Food science and technology graduates are no exception (Coorey & Firth, 2013:20). The inadequate number of graduating food scientists and technologists may partly explain the observed tendency by employers to employ graduates who do not necessarily hold a qualification in food science and technology. Graduates in related disciplines, such as microbiology, chemistry or biochemistry, are being employed to fulfil the role of food scientists and technologists. Employing graduates other than food science and technology graduates may create the perception among employers that the graduates they employ do not fully meet their needs.
Another reason for not satisfying the needs and expectations of societal stakeholders may be that the learning outcomes desired of South African food science and technology graduates have not yet been empirically determined through interaction with the relevant societal stakeholders; this consideration led to the motivation for this study. An immediate limitation in determining the requirements of societal stakeholders is that there is not always commonality between their expectations and the varied expectations among employers; this fact may have influenced the outcome of this study (Adeyemo et al., 2010:102; Pillai, Khan, Ibrahim & Raphael, 2012:188).

Within the South African context, food science is the domain of traditional academic university education, while food technology is fostered through career-focused vocational education mainly offered by former ‘Technikons’. A further differentiation is that food technology programmes typically incorporate work-integrated learning into the curriculum as a period of work placement within the food, beverage or allied industries. However, food science and food technology graduates work side-by-side and need to meet the requirements of the same community and societal stakeholders. It has become general practice in South Africa for employers to interchangeably use the job title ‘food scientist’ or ‘food technologist’, without necessarily referring to the qualification held by the graduate (personal experience).

Therefore, this study assumed that the knowledge, skills and capabilities required to ‘become’ a South African food scientist or food technologist are closely related.

1.2.3 Guidelines for food science and technology education

A study of this nature is not conducted in a vacuum. There are educational guidelines available for undergraduate food science and technology programmes from the IFT (2011:7). There are also existing descriptions of food science and technology-specific competencies required of graduates entering the workplace. Examples of such food science and technology-specific competencies include those of the Canadian International Union of Food Science and Technology (IUFoST), The United Kingdom (UK) Institute of Food Science and Technology (IFST), and the Trackfast_EU project (Flynn et al., 2013:247; Ho, Lindblom & Wahnström, 2011:4).
1.2.4 The research idea: enhancing food science and technology education

Internationally available guidelines for food science and technology education (IFT, 2011:7; IFT, 2019:6-8) are sometimes used to inform the learning outcomes of the food science and technology higher education programmes offered in South Africa. Unfortunately, the relevance of these educational guidelines in the South African context has not yet been examined. More importantly, little evidence was found of empirical research conducted within South Africa that interrogated the needs and expectations of societal stakeholders of new graduate food scientists and technologists. This lack of empirical evidence formed the initial motivation for this study, namely, to identify what graduate capabilities, or combined generic and discipline-specific attributes, knowledge, skills and competencies, are required from newly graduated food scientists and technologists to meet the expectations of South African societal stakeholders.

It is not adequate to only identify the graduate capabilities that are desired by societal stakeholders; strategies and approaches must be put in place to facilitate the development and enhancement of these desired capabilities in preparing graduates to be successful in an unknown future (Barnett, 2004:247). Yorke (2006:14) observes that ‘a pedagogy for employability’ is complex, implying that teaching and learning are multifaceted and require careful planning to facilitate the teaching, learning and assessment of generic graduate attributes and employability skills. Within South Africa, the inclusion and enhancement of generic graduate attributes such as employability skills are reported to have received little attention (Bezuidenhout, 2011:3; Coetzee, 2012b:26). Therefore, this study proposed a facilitation process aimed to support and enhance the effectiveness of academic staff in developing the necessary graduate capabilities of food science and technology students within the existing undergraduate food science and technology programmes in which they teach.

To achieve the facilitation process among academic staff, a conceptual framework was developed to inform the development of educational strategies to empower and assist the academic staff in improving their teaching, learning and assessment practices. The facilitation process was aimed at familiarising the academic staff with
several theories of teaching and learning pedagogies that have been suggested to facilitate and encourage student learning in higher education (Ashworth, Brennan, Egan, Hamilton & Sáenz, 2004:2; Fry, Ketteridge & Marshall, 2009:8, 18). Teaching and learning methods which ensure that students take charge of their own learning, is recognised as one of the most successful ways to achieve learning during higher education studies, in addition to preparing them for life-long learning (Kearns, 2001:63). Therefore, the academic staff will be assisted to identify student-centred approaches, more especially, approaches that incorporate meaningful experiences (Fry et al., 2009:15; Hackman & Oldham, 1976:250; Kolb, 1984:141). These include workplace experiences (Usher, 2009:174) and integrated contextual learning (Coorey & Firth, 2013:20) to enhance their teaching, learning and assessment practices. These approaches and experiences will be presented to academic staff for consideration as possible methods to support students in taking control of the learning process (Kass, Vodanovich & Khosravi, 2011:56), thereby enabling students to develop and enhance the required graduate capabilities aligned with the findings of the situation analysis of this study.

1.2.5 Concluding remarks

The motivation for this study was based on:

- The limited available literature identifying the food science and technology-specific graduate capabilities required by South African societal stakeholders.
- The general feeling expressed by South African societal stakeholders that food scientists and technologists do not meet their expectations when they first enter employment after graduating.
- No literature was located that proposes strategies for developing and enhancing the graduate capabilities of food scientists and technologists.

1.3 DESCRIPTION AND DEFINITION OF CENTRAL CONCEPTS

The required graduate abilities are complex and multifaceted, and need to meet an array of expectations, such as workplace readiness and employability, or continuing
with postgraduate studies. Further, the terms used when describing the skills and capabilities of graduates are often based on policies specific to a region and/or country. To illustrate this, Oliver (2011:7) suggests that Australian higher education refers to generic skills and qualities as ‘graduate attributes’, and a combination of discipline-specific outcomes and generic skills and qualities as ‘graduate capabilities’. Scrutiny of Yorke and Knight's (2006:3) definition of employability echoes the statements of graduate attributes developed by Australian universities (Oliver, 2011:11), indicating that the terms are used interchangeably. However, within the UK, ‘employability’ rather than ‘graduate attributes’ is more frequently used to describe generic skills and qualities (Oliver, 2011:11). It follows that the many terms used to describe the desired characteristics of higher education graduates are used synonymously, which can lead to confusion. For this reason, this section attempts to describe and define the central concepts in terms of this study.

1.3.1 Generic graduate attributes and graduate capabilities

‘Generic graduate attributes’ refer to the broad characteristics that graduates should develop during their higher education undergraduate studies (Hill, Walkington & France, 2016:156; Kruger, 2014:8) to prepare them to be productive members of society (Bowden, Hart, King, Trigwell & Watts, 2000:3). Generic graduate attributes encompass and are associated with the concepts of ‘employability skills’, ‘graduateness’ (refer to 1.3.1.1) and personal attributes (refer to 1.3.1.5). Holmes (2013:1044) suggests that rather than expressing different opinions, employability and graduateness are the same concept. However, other authors support that, although interrelated, the concepts may be viewed as separate aspects of generic graduate attributes (Barnett, 2004:248).

In contrast, ‘graduate capabilities’ are the combination of generic graduate attributes together with the desirable academic-, discipline- and/or vocation-specific knowledge, expertise and skilful practices which are required to fulfil the requirements of employment in a profession or occupation (Oliver, 2011:7). Graduate capabilities are the practical abilities and qualities required to ‘become’ a graduate (Barnett, 2004:248), who can act effectively within a discipline, profession or vocation (Oliver 2011:7). Graduate capabilities are enhanced by developing the generic graduate attributes and skills.
attributes within the context of the discipline, together with the more specific graduate attributes needed to be effective in the discipline, vocation or profession. Within South Africa, Griesel and Parker (2009:6) adopted the term ‘combined graduate attributes’ to describe graduate capabilities.

Figure 1.2 conveys the interrelated concepts that form the basis of graduate capabilities as proposed by this study.

In summary, graduate capabilities as viewed in this study are suggested to include the following:

- Generic graduate attributes (Oliver, 2011:7), generally recognised as essential to employability (Lowden et al., 2011:4);
- graduateness or metacognition and ‘learning to be’ through personal and scholarly development (Barnett, 2004:247);
- personal attributes, including human qualities and personality traits, and learned behaviour such as beliefs, identity and self-worth (Hinchliffe & Jolly, 2011:565); and
- academic-, discipline- and vocation-specific knowledge, expertise and skilful practices which are required to fulfil the requirements of a profession or occupation (Akkermans, Brenninkmeijer, Huibers & Blonk, 2012:258; Andrews & Higson,
These interdependent concepts collectively represent the characteristics that higher education might strive to enhance in students to develop them into ‘holistic’ graduates who will meet the expectations of societal stakeholders, including employers (Barnett, 2006:62; Chipchase, Buttrum, Dunwoodie, Hill, Mandrusiak & Moran, 2012:3; Pegg, Waldock, Hendy-Isaac & Lawton, 2012:51; Tan & French-Arnold, 2012:3; Tran, 2016:61). Each of the concepts proposed by this study as the foundation of graduate capabilities will be further explored.

1.3.1.1 Generic graduate attributes

Higher education, in trying to articulate the characteristics and qualities unique to their students, describe them in terms of ‘generic graduate attributes’, although the term lacks a “clear theoretical or conceptual base” and is open to many interpretations (Barrie, 2004:261); a view supported by Kanuka and Cowley (2017:61). Barrie (2006:217), in agreement with the often-cited definition of Bowden et al., (2000:3), defines generic graduate attributes as:

*Skills, knowledge and abilities of university graduates, beyond disciplinary content knowledge, which are applicable in a range of contexts and are acquired as a result of completing any undergraduate degree.*

However, graduate attributes, far from being generic, are proposed to differ widely depending on factors such as geographical area, government policy, institutional goals and discipline of study (Barnett, 2006:61; Barrie, 2006:262; Cleary, Flynn, Thomasson, Alexander & McDonald, 2007:12; Holmes, 2013:1044; Jones, 2009:85). Furthermore, graduate attributes are reported to be best developed in the context of the discipline, together with the requirements of the discipline to be effective (Oliver, 2011:7); thus, being specific in nature rather than generic. It follows that discipline-specific graduate attributes are educational outcomes that inform not only the curriculum design, but also the teaching and learning pedagogies that are adopted to
facilitate learning within the higher education environment (Barrie, Hughes & Smith, 2009:2).

Within the South African context, graduate attributes are described by Griesel and Parker (2009:5) as the “knowledge, skills, competencies and values” that a graduate should demonstrate to achieve employability. This description implies that graduate attributes, rather than being generic, are developed within the context of the discipline so that the graduate is effective in employment (Griesel & Parker, 2009:5; Hill et al., 2016:156). To emphasise this requirement, the South African Qualifications Authority (SAQA) (2012:3) include ten ‘applied competencies’ that are prescribed when developing the content of the qualification level descriptors for each level of the National Qualifications Framework (NQF) (SA DHET, 2012a:11 & 2013a:7; SAQA, 2014:12). The ‘applied competencies’ must be integrated to form a generic framework which allows discipline-specific skills and unique employability skills to be incorporated into qualifications (SAQA, 2012:4). It must also include skills such as critical thinking, effective communication, leadership and the ability to make use of technology, among others. However, the South African requirements also promote citizenship and social responsibility through ethical, accountable and professional practice. This implies that within the South African context, graduate attributes consist of at least two categories of attributes, namely those associated with finding and being successful in employment or employability, and those associated with citizenship and the ability to contribute towards society (Chetty, 2012:3).

### 1.3.1.2 Employability skills

Employability can be viewed as the capability to secure and be successful in a graduate-level job (Yorke & Knight, 2004:3). However, employability has evolved from preparation and the ability to obtain and retain employment, to include much more than demonstrating generic core competencies or transferable skills (Coetzee & Potgieter, 2012:3; Griesel & Parker, 2009:5; Glover et al., 2002:293; Yorke, 2004:410). Typically, employability skills are viewed as promoting graduates’ suitability for employment, which in turn is dependent on the acquisition of the ‘hard’ academic-, discipline-, or vocation-specific knowledge, competencies and skills required to do the job. However, employers often view the discipline-specific learning
outcomes of a higher education programme as less important than employability skills when graduates take up employment for the first time (Hinchliffe & Jolly, 2011:571; Robles, 2012:462).

The context in which employability is used differs widely and is often informed by government initiatives and policies, especially when higher education policy dictates the definition (Tan & French-Arnold, 2012:2; Yorke & Knight, 2004:5). Consequently, the use and meaning of the term ‘employability’ varies between regions, such as Asia (Tan & French-Arnold, 2012:2) and Europe (Flynn et al., 2013:247), and countries, including Australia (Bridgstock 2009:31; Oliver, 2010:80; Oliver, 2011:120), Canada (Bridgstock, 2009:31), the UK (Bridgstock, 2009:31; Pool & Sewell, 2007:278; Yorke & Knight, 2004:5) and South Africa (CHE, 2011:1; Griesel & Parker, 2009:7), to name a few. To demonstrate this, the UK and Australia refer to employability as the generic skills and qualities required by employers (Oliver, 2011:120), and they often do not differentiate employability skills from generic graduate attributes. However, employability is only one facet of a successful graduate, and it is acknowledged that the personality traits and learned behaviour associated with graduateness also plays a role in enhancing employability (Pandit, Preethi, Vijaylakshmi & Wallack, 2015:303; Tymon, 2013:843).

In the United States of America (USA), employability implies more than generic skills and competencies, and extends to personal attributes such as attitudes, ethics and values (Steur et al., 2012:862). South Africa has adopted this same approach and describes the generic graduate attributes more broadly than generic skills associated with employability (Griesel & Parker, 2009:7; Steur et al., 2012:862). The definition of employability accepted in regions or countries through policy, or even at the level of higher education institutions, subsequently informs the strategies and approaches that are implemented to embed the attributes of employability into the curriculum and the methods of learning, teaching, and assessment (Yorke & Knight, 2004:2).

1.3.1.3 The concept of graduateness

Graduateness is described as stimulating scholarship and the intellectual development of the student (Griesel & Parker, 2009:8; Steur et al., 2012:862) to
‘become’ a graduate (Barnett, 2004:248). Therefore, graduateness implies more than generic graduate attributes or discipline-specific knowledge, skills and capabilities, and instead captures the transformation of identity through personal and scholarly development (Barnett, 2004:248; Glover et al., 2002:303; Steur et al., 2012:862). Inherent to graduateness is the ability to remain flexible and adaptable to changing circumstances, and to engage in life-long learning to remain informed and up-to-date (Barnett, 2004:247). Most importantly, graduateness represents the student’s attitude towards knowledge and continual life-long development, and how the student views the world and his/her community (Barnett, 2004:248; Coetzee & Potgieter, 2012:2). The characteristics of graduateness are thus reliant on the personal attributes, qualities and values of a graduate (Barnett, 2004:247; Barnett, 2006:61; Griesel & Parker, 2009:5; Kruger, 2014:8), including the personal attributes and qualities specifically required by the discipline, vocation or profession (Barrie, 2004:272; Holmes, 2013:1046; Lowden et al., 2011:vii). Human dispositions and qualities such as judiciousness, thoughtfulness, modesty, resilience, receptiveness, alertness and resolution are captured through the concept of graduateness, some of which are common to employability (Barnett, 2009:248). The terms ‘graduate identity’ and ‘graduateness’ are often used interchangeably (Hinchliffe & Jolly, 2011:564), although Holmes (2013:1045) proposes that this is only applicable if graduateness is viewed through a realist lens.

1.3.1.4 The relationship between employability and graduateness

Employability and graduateness are complex and multi-dimensional concepts which are difficult to capture (Andrews & Higson, 2008:412), as there are varying views on the meaning of each. For some authors, they are closely related and ‘two sides of a coin’ rather than separate concepts (Bagshaw, 1997:189; Coetzee & Potgieter, 2012:3; Glover et al., 2002:304; Holmes, 2013:1044). This view is supported by Barrie (2004:262), who suggests that generic graduate attributes can be characterised by interconnecting the concepts of employability and graduateness. For others, employability and graduateness are outcomes of different streams of education – the so-called ‘binary divide’ – with graduateness being a product of traditional academic education, and employability a product of vocational and professional education.
(Glover et al., 2002:303; Gowdy, 1994:363; Teichler, 2003:175). Other authors even propose employability to be a subcomponent of graduateness (Coetzee, 2012a:120).

In the context of this study, the concepts of graduateness and employability are entwined and are predisposed by the personal attributes, both cognitive and behavioural, of the graduate. The successful graduate must be developed holistically and should be well-rounded (Quinlan, 2011:5), exhibiting the skills and attributes which embrace employability and graduateness to be of optimal benefit to societal stakeholders (Barnett, 2006:51; Steur et al., 2012:864). Furthermore, the graduates’ capability to continuously develop, refine and realign their skills and attributes during employment is paramount in meeting the requirements of the complex postmodern world (Barnett, 2006:61). Typically, graduates must engage with life-long learning to keep pace with the knowledge generation and the rapid changes of technology in the modern workplace (Barnett, 2004:247; Barrie, 2011:1; Steur et al., 2012:862).

1.3.1.5 Personal attributes

‘Personal attributes’ is the term frequently used to describe the attributes associated with human dispositions, behavioural skills and psychological attributes (Barnett, 2009:434; Cleary et al., 2007:7). Personal attributes include both cognitive and behavioural skills (Pegg et al., 2012:30). In attempting to define the personal attributes of graduates, Chipchase et al. (2012:8) suggest they are the “non-skill behaviours and attitudes” that are essential to the success of the graduate to meet the requirements of the societal stakeholders. Some employers even suggest that personal attributes are more important in the selection of an employee than generic employability skills, job-specific skills and the discipline-specific expertise and capabilities of the graduate (Bull, 2010:23; Chipchase et al., 2012:9).

Fundamentally, the personal attributes, attitudes and values of the student entering higher education are the foundation on which desirable graduate capabilities are constructed (Barnett, 2004:247). Many personal and psychological attributes are inherent to the personality of the graduate (Bezuidenhout, 2011:73), and as such are largely beyond the control and scope of higher education, per se (Tyron, 2013:845); apart from the targeted selection of students which may well imply exclusion. However,
higher education can play a role in further developing some of the behavioural skills, psychological attributes and the unique identities of graduates (Al-Alawneh, 2009:34; Bezuidenhout, 2011:73; Hinchliffe & Jolly, 2011:565; Matthews & Candy, 1999:50; Rae, 2007:607). This may be achieved by facilitating the transformation of all higher education students through personal and intellectual development (Coetzee & Potgieter, 2012:3; Griesel & Parker, 2009:8; Steur et al., 2012:863).

In this study, personal attributes are considered as separate to, but closely associated with, employability and graduateness, and are influenced by the unique personality traits of the graduate (Tymon, 2013:845). Apart from the personal attributes associated with generic employability skills and graduateness, some personal attributes may be required which are specific to the discipline, vocation or profession (Barnett, 2009:434). As such, personal attributes are an essential aspect of the desirable characteristics of a graduate (refer to Figure 1.2).

1.3.2 Food science and technology

Food science and technology is a multi-disciplinary science-based discipline. To contextualise what food science and technology entails, the definitions of food science and food technology are examined. The IFT (2011:4) defines ‘food science’ as:

*The discipline in which engineering, biological, and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public.*

Food science is therefore complex, multi-disciplinary and related to the understanding of the nature of food and food processing principles (IFST, 2015:2; IFT, 2011:4; Potter & Hotchkiss, 1998:1). ‘Food technology’, on the other hand, is generally recognised as the application of food science (Potter & Hotchkiss, 1998:1), to the “selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food” (IFT, 2011:4).
This implies that food science and food technology are closely associated, and seemingly cannot be separated from each other, as one is the application and use of the other (IFT, 2011:4; Kostaropoulos, 2012:111). Consequently, in practice, the terms ‘food science’ and ‘food technology’ are often used interchangeably as there is little differentiation between the two. The term ‘food science and technology’ is widely accepted to encompass both (IFST, 2017:1; IFT, 2011:4; IUFoST, n.d.:1; South African Association of Food Science and Technology (SAAFoST), 2016:1).

Likewise, an examination of the definitions of food science and food technology supports the notion that there is little that distinguishes a food scientist from a food technologist, apart from the fact that the latter implies more application of the principles of food science. In support, the IFT describes food scientists and technologists as “versatile, interdisciplinary, and collaborative practitioners in a profession at the crossroads of scientific and technological development” (Floros et al., 2010:572). This description does not differentiate between food scientists and food technologists and has led to the widespread use of the term ‘food scientists and technologists’. Based on this premise and the context of this study, the terms food science and technology and food scientists and technologists were adopted.

1.3.2.1 Food science and technology education

The discipline-specific prerequisite core knowledge and technical skills for food science and technology are defined in this study as those skills acquired through understanding, articulation and practice to allow cognitive growth of the student to ‘become’ (Barnett, 2009:429; Jarvis, 2009:159) a food scientist and technologist. Furthermore, it is recognised that discipline-specific knowledge and technical skills change over time, and the graduate will be required to embark on life-long learning to adapt to changes in the workplace.

Limited literature was located relevant to food science and technology education in South Africa. A study by Jideani and Jideani (2012:34) outlined a process to align the programme learning objectives with assessment objectives of food science and technology offered at a South African higher education institution. However, the
alignment of the programme learning outcomes to address the needs and expectations of societal stakeholders was outside the scope of the study.

1.3.3 Working definitions

Many of the concepts central to this study, such as food science and technology, generic graduate attributes, employability and graduateness, have variable definitions which can lead to confusion. Consequently, this section aims to describe and define the working definitions of the central concepts used in this study.

1.3.3.1 Food science and technology

The previously described definitions of the IFT (2011:4) are adopted for this study (refer to 1.3.2). Food technology is viewed as the application of food science, and the two cannot be detached from one another, and in this study are referred to as ‘food science and technology’.

a) Food scientist and food technologists

Within the context of South Africa, food scientists are products of traditional academic university qualifications, while food technologists are products of vocational programmes which incorporate a period of work-integrated learning. In reality, food scientists and food technologists are employed side-by-side within the food, beverage and allied industries. Therefore, this study assumes that food scientists and food technologists must have similar graduate capabilities to meet the needs and expectations of South African societal stakeholders.

1.3.3.2 Graduate

Within the South African context, Griesel and Parker (2009:9) include certificate, diploma and degree qualifications into the category of undergraduate qualifications. The Baccalaureus Technologiae or Bachelor of Technology (B. Tech.) which will be phased out shortly (SA DHET, 2012a:13 & 2014:24) but is still relevant to this study, is also included as an undergraduate qualification. The term ‘graduate’ is used to describe students graduating with an undergraduate qualification. Postgraduate
programmes, including professional degrees, Honours, Masters and Doctoral qualifications, are outside the scope of this study.

1.3.3.3 Generic graduate attributes

Generic graduate attributes refer to the broad characteristics, skills and competencies that all graduates should develop during their undergraduate studies and are independent of the field of study (Hill et al., 2016:156; Kruger, 2014:8). Generic graduate attributes, as conceptualised in this study, include and are interrelated with the concepts of employability, graduateness and personal attributes expected from all graduates of higher education.

1.3.3.4 Specific graduate attributes

Specific or ‘combined’ (Griesel & Parker, 2009:5) graduate attributes are the explicit desirable characteristics, including knowledge, skills and competencies desired from a graduate within a specific discipline, vocation and/or profession, to gain and be effective in employment. In this study, the specific/combined graduate attributes are synonymous with graduate capabilities (refer to 1.3.3.5).

1.3.3.5 Graduate capabilities

Within the South African context, graduate capabilities are synonymous with “combined graduate attributes” that encompass the “knowledge, skills, competencies and values of new graduates” (Griesel & Parker, 2009:5). Graduate capabilities, as conceptualised in this study, refer to the generic graduate and personal attributes associated with employability skills and graduateness that are expected from all graduates, in combination with the more specific graduate attributes and essential food science and technology-specific knowledge, skills, and competencies that newly graduated food scientists and technologists are expected to demonstrate (refer to Figure 1.2). All identified graduate capabilities will be the ‘perceived’ capabilities according to participants.
1.3.3.6 Employability

This study views employability as more complex than a list of skills. Rather, to demonstrate employability, a food scientist or technologist requires the development of the employability skills generally associated with the generic graduate attributes, in the context of the discipline. The required employability skills should support graduates to be effective in the workplace environment and the broader community. Therefore, the definition of employability proposed by Yorke and Knight (2006:3) is adopted by this study as follows:

*A set of achievements – skills, understandings and personal attributes – that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.*

1.3.3.7 Graduateness

In the context of this study, graduateness is viewed as the intellectual development, transformation and personal growth of the graduate. It contrasts but is interdependent on developing generic graduate attributes, including employability skills (Steur et al., 2012:864; Walsh & Kotzee, 2010:36).

1.3.3.8 Personal attributes

Personal attributes are the human characteristics associated with personality traits, qualities, and values related to generic graduate attributes. In addition, more explicit personal attributes may be desirable which are specific to the discipline, vocation or profession (Barnett, 2009:434).

1.3.3.9 Educational strategies

Mintzberg (1987:11) proposes several definitions for the word ‘strategy’, including a plan, ploy, pattern or perspective. Strategies are developed in advance and are purposive, involving both content and process, and can be developed at different
levels such as international, national, organisation, department or individual levels (Mintzberg 1987:12). This study adopts the meaning of strategy as a specific plan of action at the level of the academic staff teaching in the discipline of food science and technology. Educational strategies are conceptualised as the approaches that aim to enhance the knowledge, skills and competencies of the academic staff through a facilitation process. The facilitated academic staff will be able to implement interventions to develop and enhance the required graduate capabilities of food science and technology students during their undergraduate studies.

1.3.4 Theoretical and conceptual frameworks

The theoretical framework is based on existing theory in the fields of skills development in higher education and food science and technology education (Adom, Hussein & Agyem, 2018:439). In the empirical first phase of this study, a questionnaire was developed based on existing knowledge, and data were collected through stakeholder engagement (refer to Figure 1.3).
The situation analysis identified the graduate capabilities required of newly graduated food scientists and technologists as expected by societal stakeholders. Based on the findings of the situation analysis, challenges were formulated to be addressed by the academic staff teaching food science and technology students to achieve the outcome of demonstrating the required graduate capabilities when they graduate. The thinking map for this study aimed to integrate and interconnect the concepts, the findings of the empirical research and the theoretical assumptions that formed the foundational thinking of this study (Adom et al., 2018:439; Babbie & Mouton, 2001:77; Leshema & Trafford, 2007:93) as shown in Figure 1.4.
The second phase of this study established a conceptual framework to direct the development of the educational strategies for a facilitation process aimed at assisting the academic staff in enhancing their teaching, learning and assessment practices. By empowering and supporting the academic staff to create an environment conducive to student-centred learning, future food science and technology students will be assisted to achieve the required graduate capabilities, aligned with the findings of the situation analysis.

1.3.5 Concluding remarks

This section specifically aimed to describe and define the central concepts as adopted and used in this study. To clarify, this study assumed that the graduate capabilities required of food science and technology graduates comprised an amalgamation of the following: a) the generic graduate attributes including employability skills and the characteristics of graduateness; b) the desirable personal attributes; and c) the
discipline-specific knowledge, skills and competencies that graduates must demonstrate to be effective in the discipline and meet the expectations of societal stakeholders.

This study adopted a two-phased approach. Firstly, the graduate capabilities required of food scientists and technologists were determined through a situation analysis and interaction with the relevant stakeholders. Following this, a conceptual framework that informs strategies aimed at cultivating the positive attitude, motivation and the enhanced educational knowledge, skills and competencies of academic staff teaching food science and technology undergraduates, was developed.

1.4 THE RESEARCH PROBLEM STATEMENT

1.4.1 Research problem

It is acknowledged that higher education has a responsibility to produce adaptable and employable graduates capable of positively contributing to the economy, both immediately and over time (Archer & Chetty, 2013:134; Sin & Amaral, 2017:97). However, it is a worldwide tendency that employers are increasingly voicing their concerns that, in general, the graduates are not meeting their expectations, especially when they first take up employment (Archer & Chetty, 2013:135; Chetty, 2012:5; Litchfield et al., 2010:519; SA DHET, 2011:3; Wilton, 2011:13 & 2012:604). This sentiment is also expressed by South African employers of food scientist and technology graduates. There is also, in general, little understanding or interaction between higher education institutions, employers and other relevant stakeholders, including students, to reach agreement on the graduate capabilities required to meet the needs of each (Barnett & Coates, 2005:5). Higher education institutions often stipulate generic graduate attributes which they want their graduates to display based on policy frameworks and available literature, rather than through engagement with employers and other relevant stakeholders who may have different perspectives of what is needed in the workplace (Barrie, 2004:263; Barrie et al., 2009:2). Institutional generic graduate attributes seldom take the uniqueness of the discipline, vocation or profession into consideration, although it is widely supported that graduate attributes
are best developed within the context of the discipline (Barnett & Coates, 2005:54; Flynn et al., 2013:247; Holmes, 2013:1046; Lowden et al., 2011:v; Oliver, 2011:2).

Presently the desirable discipline-specific graduate attributes of South African food scientists and technologists are not known and there is limited literature available relevant to food science and technology education in South Africa. Internationally available guidelines, core competencies and requirements for recognition and/or accreditation of undergraduate food science and technology programmes (IFST, 2015; IFT, 2011:6-8; IUFoST, n.d., Flynn et al., 2013:246) are available. However, there is little evidence to support the applicability of these guidelines within the South African context. Additionally, there is little information about the methods, including consultative processes, followed to develop the internationally available educational guidelines. The exception to this is the systematic identification of the required knowledge, skills and attributes of food scientists and technologists within the European Union (EU) (Flynn et al., 2013:247). Therefore, the need was identified to empirically determine the required graduate capabilities of food scientists and technologists within South Africa through engagement with the relevant societal stakeholders (Tran, 2016:62).

Once the discipline-specific graduate attributes of South African food scientists and technologists are known, higher education must endeavour to facilitate the enhancement of these capabilities. However, the desired graduate capabilities cannot be left to individual academics to interpret and incorporate into their teaching and assessment in isolation and with little support or planning (Barrie, 2004:261; Oliver, 2011:121). Rather, higher education must engage with the curriculum and correspondingly, teaching and learning practices, that may facilitate the enhancement of graduate capabilities (Barrie, 2004:261). Therefore, this study proposed effective strategies to assist the academic staff teaching food science and technology students to develop and enhance the defined graduate capabilities required of food scientists and technologists (Oliver, 2011:121). Ideally, an approach that includes feedback from the relevant stakeholders, including the graduates, is needed to assess if the required graduate capabilities are demonstrated by newly graduated food scientists and technologists (Barrie et al., 2009:2; Oliver, 2011:121). Consequently, the second phase of this study proposed a conceptual framework to achieve the outcome of
academic staff enhancing their teaching and learning approaches through specific educational strategies, and in so doing be capable of implementing an engaged learning environment and addressing certain challenges identified through the empirical findings in the future. The proposed educational strategies are to be presented to the academic staff teaching food science and technology students in the future. By implementing the planned facilitation process developed in this study, the outcome of academic staff empowered with the educational knowledge, skills and competencies needed to support students to attain the required graduate capabilities may be achieved.

1.4.2 Research questions

Research questions guide the research study, including the methodological choices made (Babbie & Mouton, 2001:75; Buchanan & Hvizdak, 2009:37). Research questions must meet fundamental criteria, such as formulating the research problem clearly and being answerable by collecting and analysing relevant data (Ary, Jacobs, Sorenson & Walker, 2014:37, 455). The main research question and sub-questions of this study were formulated in such a way as to achieve the aims of the study (Ary, et al., 2014:455; Babbie & Mouton, 2001:75; Lewis, 2003:48). Therefore, the main research question for this study was formulated as:

What educational strategies can be formulated to facilitate the professional development of the academic staff teaching undergraduate food science and technology students to deliver food science and technology graduates who will meet the requirements and expectations of societal stakeholders?

The following sub-questions needed to be addressed to answer the main research question:
Sub-question 1:
What graduate capabilities are required of newly graduated food scientists and technologists that will meet the requirements and expectations of South African societal stakeholders?

Sub-question 2:
To what extent are the international food science and technology educational requirements and guidelines identified through literature applicable in the South African context?

Sub-question 3:
How can the academic staff be facilitated to have the necessary attitudes, knowledge, skills and capabilities to optimally enable undergraduate food science and technology graduates to demonstrate the required graduate capabilities?

1.4.3 Research aims and objectives

Firstly, this study aimed to empirically identify and describe the graduate capabilities required of South African food science and technology undergraduates through engagement with societal stakeholders (Tran, 2016:62). The required graduate capabilities comprised a complex combination of abilities in respect of generic graduate attributes, including employability and work-readiness, citizenship, scholarship associated with graduateness, personal attributes and qualities, and the discipline-specific knowledge, skills and competencies required of food scientists and technologists. In identifying the food science and technology graduate capabilities, it was intended to capture the broader context of ‘becoming’ (Jarvis, 2009:159) a food scientist and technologist, rather than simply ‘knowing’ about food science and technology. The importance of producing food science and technology graduates who are adaptable to the changing needs of society through the capacity for life-long learning was central to this study (Barnett, 2009:429; Barrie, 2011:1).
To identify the graduate capabilities required of South African food scientists and technologists, a questionnaire was developed and distributed to collect data from stakeholders relevant to this study, including government, employers, food scientists and technologists and academics involved with food science and technology education.

Once the graduate capabilities required of food scientists and technologists were identified through the situation analysis, challenges to achieving these graduate capabilities were formulated. To address the challenges, the need for a facilitation process to support and assist the academic staff teaching food science and technology students to overcome these challenges was identified. In view of the overarching aims, the main objective of the study was to:

Formulate a conceptual framework to develop educational strategies to be implemented in the future to facilitate a positive attitude and the educational knowledge, skills and competencies of academic staff teaching food science and technology students.

The main objective is divided into the following more specific theoretical and empirical objectives:

- Conduct a situation analysis making use of a self-developed questionnaire to identify the graduate capabilities required of South African food science and technology graduates.
- Identify challenges based on the findings of the situation analysis that academic staff teaching food science and technology students must address.
- Develop a conceptual framework to guide a future facilitation process of the academic staff to enable them in addressing the challenges.
- Formulate educational strategies that might facilitate a positive attitude and the educational knowledge, skills and competencies of academic staff through a workshop that will be conducted in the future.
1.5 RESEARCH DESIGN AND METHODOLOGY

1.5.1 Research paradigm

In the context of this study, the research paradigm relates to fundamental philosophical considerations which are foundational to the outcomes of the study (Aliyu, Bello, Kasim & Martin, 2014:79; Chilisa & Kawulich, 2012:2-3; Creswell, 2014:35; Wayhuni, 2012:69). The paradigm and associated metatheory, in turn, influence the theory selected to guide the research process and the methodology selected to conduct this study (Musa, 2013:41; Scotland, 2012:9).

The paradigm of positivism was selected as an appropriate scientific frame of reference to guide the research process of this study (Kivunja & Kuyini, 2017:26; Scotland, 2012:9; Wallis, 2010:80). Positivism is a philosophy of naïve realism and objectivity that generates universal and generalisable knowledge based on explanation of measurable variables (Aliyu et al., 2014:79; Ary et al., 2014:25). The paradigm of positivism was chosen since a positivist approach supports the aims and objectives of the study and what is hoped to be achieved (Creswell, 2014:36; Babbie & Mouton, 2001:49). The metatheory of critical realism is core to the paradigm of positivism (Sousa, 2010:455; Wallis, 2010:78). The paradigm of positivism and the metatheory of critical realism, in turn, informed the methodological and theoretical assumptions and choices made for this study.

1.5.2 Research design

An exploratory, deductive, non-experimental quantitative design was identified as most suitable to address the research questions (refer to 1.4.2) and to accomplish the previously stated aims and objectives of this study (refer to 1.4.3) (Ary et al., 2014:447). Deductive reasoning is associated with quantitative methodology where collected data are used to describe, explain, predict, confirm or control a phenomenon (Creswell, 2012:19). A two-phased approach was used.
1.5.3 Research method

The initial phase comprised two stages. Initially, a deductive conceptual framework was determined through a review of literature. Following this, a self-developed questionnaire was deployed as a web-based survey. Survey research is a quantitative approach associated with the paradigm of positivism (Ary et al., 2014:450; Babbie & Mouton, 2001:49). The web-based survey collected responses from societal stakeholders identified as relevant to this study, such as government, food scientists and technologists, employers of food scientists and technologists, and representatives of organisations active in food science and technology. The empirical data were collected using a Likert-type rating scale, while providing additional data through opportunities for comments and responses to open-ended questions. The data collected through the survey allowed deconstruction to establish the food science and technology graduate capabilities required as identified by the relevant South African societal stakeholders. Based on the findings of the situation analysis, challenges were identified that needed to be addressed by the academic staff teaching food science and technology to support students to achieve the required graduate capabilities.

The second phase of this study also comprised two stages. Firstly, a conceptual framework was developed to facilitate a positive attitude and the educational knowledge, skills and competencies of the academic staff teaching food science and technology students. Based on the conceptual framework, educational strategies were developed for the facilitation process of the academic staff. The facilitation process aimed to assist the academic staff in overcoming the challenges identified through the situation analysis. By having the ability to address the challenges, the academic staff will support food science and technology students to achieve the required graduate capabilities (Sales, Smith, Curran & Kochevar, 2006:S43).

1.6 SIGNIFICANCE OF THE RESEARCH

This study ultimately aimed to enhance the education of South African food scientists and technologists to better meet the needs of societal stakeholders. To achieve the overall objective, the graduate capabilities required of South African food scientists and technologists as perceived by societal stakeholders had to be identified as these
are not currently explicitly outlined. The conceptual framework developed to guide the facilitation process of the academic staff teaching food science and technology students is a unique contribution to food science and technology education. The educational strategies formulated based on the proposed conceptual framework are more widely applicable than food science and technology education, and can be adapted to teaching, learning and assessment approaches of academic staff within higher education in general.

1.7 ETHICAL CONSIDERATIONS

Ethics clearance to conduct the study was obtained from the Ethics Committee of the Faculty of Education as per the University of Johannesburg and faculty requirements (Ethical Clearance Number +2014-033; refer to Annexure A). The ethical guidelines adopted for this study were based on generally accepted best practice when using focus groups (Ary et al., 2014:473) and collecting data using questionnaires administered as web-based surveys to not cause harm to the participants (Ary et al., 2014:623-4; Booth, Colomb & Williams, 2008:273; Buchanan & Hvizdak, 2009:37; Dhai & McQuoid-Mason, 2011:14). The ethical principles proposed by Dhai and McQuoid-Mason (2011:14), namely autonomy, justice, non-maleficence and beneficence, formed the foundation for the ethical considerations of this study.

Autonomy was addressed by providing potential participants with sufficient information to make an informed decision about participating in this study. Justice was addressed through reinforcing the right of the participants to withdraw from this study at any time without any negative consequences. In addition, the integrity of the findings based on the collected data were ensured through logical and systematic analysis based on best practice. Confidentiality of the focus group discussions and the data collected by the web-based survey addressed the principle of non-maleficence, although the potential weakness of web-based surveys in this regard is recognised (Buchanan & Hvizdak, 2009:37). Lastly, beneficence will be addressed through publications, training sessions and congress presentations. The outcome of the situation analysis was presented at the South African Association of Food Science and Technology conference held from the 06 – 08 September 2015, without identifying or causing harm to the participants.
1.8 STRUCTURE OF THE THESIS AND CHAPTER OUTLINES

The thesis comprises seven chapters as outlined:

Chapter One: Provides an introduction and orientation to this study.

Chapter Two: Presents the theoretical framework that informed the development of the questionnaire to identify the graduate capabilities required of food science and technology graduates.

Chapter Three: Describes the research design and methodology adopted for this study.

Chapter Four: Provides an overview of the analysis and the findings of the empirical data collected using the questionnaire developed for this study.

Chapter Five: Describes the conceptual framework developed to guide the facilitation process aimed at academic staff teaching food science and technology students.

Chapter Six: Describes the development of educational strategies to empower the academic staff to address the challenges identified through the situation analysis.

Chapter Seven: Concludes and summarises the findings and processes followed in this study, formulates recommendations, recognises limitations and identifies possible future research.

An outline of the structure and interconnections of the chapters is provided in Figure 1.5.

1.9 SUMMARY

The purpose of this chapter was to introduce and provide an orientation to this research study. The role of higher education in providing graduates who are capable
of effectively meeting the needs of societal stakeholders such as government, employers and graduates was introduced and reinforced as an essential outcome of higher education. The chapter also identified that without the explicit perceived needs of societal stakeholders being known, higher education could not realistically meet stakeholders’ expectations. Within the context of food science and technology education in South Africa, the perceived needs of societal stakeholders have not yet been empirically defined. Based on the research questions, aims and objectives of this study, an overview of the research design and process to be followed in this study was provided and the ethical considerations were described.
CHAPTER 1
Introduction & orientation

CHAPTER 2
Theoretical framework to develop the questionnaire to determine the perceived needed graduate capabilities expected from food science and technology graduates

CHAPTER 3
Research design and methodology

CHAPTER 4
Analysis and findings to identify the needed food science and technology-specific graduate attributes or 'graduate capabilities'

CHAPTER 5
Conceptual framework

CHAPTER 6
Educational strategies

CHAPTER 7
Conclusions, implications, limitations and future research

THEORETICAL FRAMEWORK

EMPIRICAL INVESTIGATION

GAP

Drafting the questionnaire

Focus group discussion & confirmation

Converted to web-based format & piloted

Survey data collection

Data analysis

Findings - the required graduate capabilities

Challenges

FACILITATION OF THE ACADEMIC STAFF

Figure 1.5: Overview and structure of the thesis
CHAPTER TWO: THEORETICAL FRAMEWORK TO IDENTIFY THE SPECIFIC ATTRIBUTES NEEDED OF FOOD SCIENCE AND TECHNOLOGY GRADUATES

The more things you read, the more things you will know. The more that you learn the more places you’ll go (Dr Seuss, 1978).

2.1 INTRODUCTION

Globally, higher education faces many challenges, including demands for widening access (Wilton, 2011:2); fluctuations in governments’ higher education policies (Adam, 2009:29; Griesel & Parker, 2009:6); the shifting demands of the economy and labour market (Chetty, 2012:2; Griesel & Parker, 2009:7; Kruger, 2014:2); calls to globalise the curriculum; and the pursuit of university rankings (Allais, 2017:147; Hazeldorn, 2015:1; Jones, 2013:97). Indeed, higher education is increasingly being called upon to be more responsive to stakeholder demands. This includes the needs of government, employers and the students themselves (Chetty, 2012:1). Employers’ demands for ‘up-to-date graduates’ who are work-ready within different environments are well documented, which is consequently developing into a growing focus of higher education (Pillai et al., 2012:188; Steur et al., 2012:861). However, the demands and needs of employers are complex, diverse, not always well defined, and may easily be misunderstood (Adeyemo et al., 2010:102; Griesel & Parker, 2009:7; Knight & Yorke, 2006:2). Ultimately, higher education also has the responsibility not only to produce ‘work-ready’ graduates, but graduates who are equipped to engage in life-long learning (Bull, 2010:16; CBI & UUK, 2009:5; Glover et al., 2002:1). Without engaging in life-long learning, graduates will not be able to keep abreast of the changing demands of the workplace resulting from economic pressure, technological advancements and new knowledge (Barnett, 2006:54; Kearns, 2001:31). Added to this situation are graduates’ own expectations that they will successfully secure meaningful employment soon after graduating (Altbeker & Storme, 2013:1; Saunders & Zuzel, 2010:Abstract). These challenges and expectations have given rise to tensions not only between higher education and the communities it serves, but also in the broader community in which it functions (Lowden et al., 2011:1; Pandit et al., 2015:303).
The purpose of this chapter is to set the background against which existing theory relevant to this study is interrogated (Adom et al., 2018:438). Theory related to what may be required from food science and technology graduates to be effective in their chosen occupation will be specifically scrutinised. The literature reviewed served as the foundation on which the data collection instrument, a questionnaire administered as a survey, was developed.

Firstly, the role and responsibility of higher education to meet the expectations of societal stakeholders for work-ready, employable graduates who are capable and effective within their chosen vocation or profession, is examined (CBI & UUK, 2009:5; Griesel & Parker, 2009:5; Samadi, 2013:17; Tymon, 2013:847). The concepts central to this study, including ‘graduate capabilities’ and the associated concepts, are presented (Oliver, 2011:7). Food science and technology education is examined with the emphasis on the discipline-specific requirements to fulfilling the needs of societal stakeholders. Mouzakitis (2010:3914) suggests that to meet the requirements of societal stakeholders, educational strategies should be based on ‘market research’ to identify their needs; a view that is supported by Tran (2016:62). Subsequently, the concepts and connections identified through literature will be used to develop the content of the data collection instrument, namely a questionnaire administered online as a web-based survey. The survey was conducted to collect data from the stakeholders relevant to this study, to answer the following research sub-questions:

### Sub-question 1:
What graduate capabilities are required of newly graduated food scientists and technologists that will meet the requirements and expectations of South African societal stakeholders?

### Sub-question 2:
To what extent are the international food science and technology educational requirements and guidelines identified through literature applicable in the South African context?

An overview of the structure of the chapter is depicted in Figure 2.1:
The literature review was conducted using a structured and systematic approach making use of software management and coding package, namely ATLAS.ti. This approach allowed concepts relevant to the study to be identified through literature, and possible connections between the concepts were made. In addition, similarities and differences between concepts were identified. The result was the development of a framework that motivated the study and informed the content of the questionnaire that was used as the data collection instrument.

2.2 THE CONTEMPORARY ROLE OF HIGHER EDUCATION IN SOCIETY

There is no single definition of higher education; nevertheless, it is generally accepted that higher education refers to post-school education usually being offered at universities or colleges (Altbeker & Storm, 2013:8; Badat, 2010:8). The Dearing Report (Dearing, 1997:70) describes higher education as “embracing teaching, learning, scholarship and research” and it is one part of a tertiary education system comprising interdependent systems of education. The University of Oxford (2012:2)
describes higher education as the “pursuit of higher order cognitive capabilities in the context of disciplinary knowledge” that is increasingly being viewed as essential to gain employment and be successful in a career (Rae, 2007:606; Yorke, 2006:2).

The aims and purpose of higher education are equally contested and seem to be far from self-evident. Some authors propose a common set of aims for higher education (Steur et al., 2012:862), while others claim this is not a practical approach and propose that the aims of higher education should be contextual; thus, it may differ between countries, types of institutions and the requirements of the community it serves (Bowers-Brown & Harvey, 2004:212; SA CHE, 2000:59; SA CHE, 2016:1). The purpose of higher education has always been highly contended with fluctuating and recurring political and social themes (Artess, Hooley & Mellors-Bourne, 2017:6; SA CHE, 2016:9; University of Oxford, 2012:1). Some of the re-emerging themes include the traditional focus of encouraging individual transformation, scholarship and citizenship, versus developing employability, work-readiness and encouraging vocational education (Star & Hammer, 2008:237; Tymon, 2013:846; Teichler, 2009:49). Added to this is the call for widening access to higher education to redress social inequality and the promotion of society in general (Andrews & Russell, 2012:33; Hazelkorn, 2013:2; Rae, 2007:607; Rata, 2016:168; SA CHE, 2011:1; University of Oxford, 2012:1; Wilton, 2011:1). Indeed, the role of higher education in the global, postmodern, knowledge society is ever-changing depending on what is needed in the context in which it operates (Allais, 2017:157; SA CHE, 2016:1).

Over time, the practice of higher education has proved to be capable of continually adapting to the changing needs of reality and society, even though this transformation may be slow (Artess et al., 2017:6; SA CHE, 2016:1). An example of the changing needs of society is the transformation of the UK’s higher education system in 1963, from an ‘elitist’ system to one of massification (Bathmaker, 2003:169). Likewise, South African higher education has moved from a racially-based ‘elitist’ system to a more inclusive democratic system that allows for widening access (Chetty, 2012:2; SA DHET, 2012b:9). Broadly speaking, the academic-oriented context of higher education is recognised to encourage scholarship through research, reading and inquiry within a chosen discipline (Bathmaker, 2003:169; Bowers-Brown & Harvey, 2004:213; Harwood, 2010:417; Steur et al., 2012:862). The focus is on cognitively
developing the capacity to learn better and the ability to construct knowledge from what is learnt (Ashworth et al., 2004:2; Bruner, 2009:159). Correspondingly, the university is sometimes viewed as the only place where knowledge exists (Usher, 2009:175). In this regard, academic knowledge derived from science or theory – which may have little relevance to practice – is emphasised (Gowdy, 1994:362; Harwood, 2010:417). Bowers-Brown and Harvey (2004:213) propose that ‘traditional’ higher education institutions see their primary role as developing the graduateness of their students, promoting postgraduate studies, producing research, and ‘creating’ new knowledge, a view which is supported by many authors (Chetty, 2012:2; Glover et al., 2002:214; Griesel & Parker, 2009:8; Harwood, 2010:417). More recently, academic-focused education has been broadened to include liberal education, which focusses on producing empowered graduates with an extensive worldview (Adam, 2009:171; Steur et al., 2012:864; University of Oxford, 2012:2).

In some cases, transformation has resulted in differentiation in the focus of higher education institutions with different interpretations and approaches to meet the requirements of society (Hazelkorn, 2013:3). For example, the pressure of government policies to develop human capital has led to the rise of the neoliberal university where the focus is on developing specific rather than diverse capabilities (Le Grange, 2011:1044). The shift to neoliberalism in higher education has encouraged some universities to engage actively with the community they serve and to conduct applied research to solve societal problems (Le Grange, 2011:1044).

Notwithstanding the different interpretations of the present role of higher education, the fact is that stakeholders, including government, professional bodies and employers, have raised concern regarding the perceived widening gap between the skills and competencies of graduates in general and what is required in the workplace (Al-Alawneh, 2009:2; Andrews & Higson, 2008:411; Deželan et al., 2016:210; Griesel & Parker, 2009:5; Pegg et al., 2012:19, Samadi, 2013:17). Pressure from stakeholders to deliver empowered, professional, productive, employment-ready graduates that meet the needs of a rapidly evolving modern workplace, and who can engage in life-long learning, continues to grow (Bull, 2010:14 & 16; CBI & UUK, 2009:5; Coetzee, 2014:890; Dearing, 1997:84; Kearns, 2001:63; Knight & Yorke, 2002:262). However, to prepare graduates to meet the labour market needs of a
knowledge-driven economy and society is a complex and fluctuating task (Allais, 2017:157; Holmes, 2013:1044), because these requirements are not necessarily generic but mostly contextual (Allais, 2017:157; Holmes, 2013:1044).

2.2.1 Higher education in South Africa

In the post-apartheid South Africa, higher education is being subjected to continual transformation to allow it to better respond to the changing needs of the country and society (Archer, 2017:1; Development Bank of South Africa (DBSA), 2010:24; Mouton, Louw & Strydom, 2013:285). To support the call for transformation, actions like massification of higher education to allow previously disadvantaged groups access were taken (Archer, 2017:1; Moloi, Mkwanazi & Bojabotseha, 2014:469; SA CHE, 2013:v-vi). This step is based on the premise that higher education is perceived as a mechanism to redress the injustices of the past and alleviate poverty (Le Grange, 2011:1044). Consequently, higher education is being viewed as the vehicle that will encourage and promote the values of democracy, including dignity, freedom and respect (DBSA, 2010:24; Rata, 2016:168; SA DHET, 2013:18; SA DHET, 2017:8; SA DOE, 1997a:1; SA DOE, 1997b:1). In addition, the belief is also held that graduates who are productive and meet the requirements of the labour market, will possibly strengthen the South African economy and make the country more competitive in the global market (DBSA, 2010:24; Rata, 2016:168). Therefore, higher education in South Africa has started to gradually shift away from offering either liberal education with the traditional focus of academic scholarship, or vocational and professional education emphasising employability, to exhibit a more inclusive approach (SA CHE, 2011:1).

The transformation of higher education in South Africa aimed to fulfil several roles (SA DHET, 2013:18), namely a) to develop the intellectual capacity and high-level skills of graduates with an emphasis on employability, adaptability and the capability for life-long learning, b) to be producers of new knowledge and the application of new and existing knowledge focusing on the needs of the community and keeping the country competitive and independent, and c) to be responsible for social justice and redress social injustices of the past. However, South African higher education has many challenges to overcome in achieving transformation. For instance, dysfunction
across the primary and secondary education sectors, underprepared students with widely varying backgrounds, experiences and financial resources and constraints, massification, and the lack of skilled academics and researchers (Chetty & Pather, 2015:3-4). The process of transformation continues to change the role of academics from research and teaching in their areas of interest, to having to align what they teach with national frameworks and to meet national priorities (Mouton et al., 2013:291). Other challenges to higher education are wider than the South African context and include internationalisation to allow mobility of graduates and international recognition through, for example, ranking systems. The drive for internationalisation of South African higher education dictates that the core functions of a university system are teaching and research, while the second-order functions, such as redress and equality, are the consequence and are dependent on the core functions (Archer, 2017:1). However, the higher education sector in South Africa is ultimately influenced not only by global trends and the need for internationalisation but also by the requirements of the local community.

In terms of the South African higher education sector preparing graduates to enter employment, a baselines study was conducted by Griesel and Parker (2009:5). The study aimed to identify employers' needs and to examine their views regarding the extent to which graduates in general are meeting their expectations. The authors identified the need to address the gaps between higher education outcomes and what employers expect from graduates. These authors also acknowledged some concerns, including graduates' inability to apply their knowledge and be ‘hands-on’ in the workplace (Griesel & Parker, 2009:5). Despite perceptions that many South African graduates remain unemployed after graduating, Altbeker and Storme (2013:2) found this was not the case. These authors concluded that this might be because the labour market is desperate for skilled and educated employees, rather than the reflection that higher education is meeting the needs of employers. As a result, there are ongoing calls to re-examine the relationship between higher education, the community and the economy within South Africa (Allais, 2017:147; SA CHE, 2016:9).
2.2.2 Skills development through higher education

Discipline-specific knowledge, skills and competencies allow a student to become specialised and proficient in a field of study and is often the basis of selecting a graduate for employment (Tymon, 2013:853). However, discipline-specific knowledge, skills and competencies are not enough for a graduate to meet the expectations of employment, citizenship and scholarship (Coetzee, 2012a:120). Increasingly, the holistic characteristics of graduates are seen in the contribution of higher education to the wider community to prepare students to contribute to the world (Barrie, 2004:263). The generic requirements of all graduates of higher education are described by several terms (Andrews & Higson, 2008:413; Bohlscheid & Clarke, 2012:8; Coetzee, 2014:80; Daniels & Brooker, 2014:66; Hooker & Whistance, 2016:156). The generic requirements are referred to as ‘generic graduate attributes’ in this study, and include employability skills to secure and be effective in employment (Bridgstock, 2009:32; Yorke, 2006:8), and the characteristics of graduateness associated with scholarship and citizenship (Barnett, 2009:429; Steur et al., 2012:862). Several authors also highlight the development of personal attributes, including qualities and attitudes which are associated with employability and graduateness (Barnett, 2009:433; Chipchase et al., 2012:3; Matthews & Candy, 1999:50) as important aspects of generic graduate attributes.

However, more recently, over and above the generic graduate attributes, the impact of the context and the discipline-specific requirements of graduates to meet the needs of societal stakeholders has been recognised (Oliver, 2011:9). The need to develop graduates holistically to exhibit not only the necessary ‘generic graduate attributes’, but also the ‘specific graduate attributes’ to meet the explicit requirements of a discipline, profession or vocation, are being increasingly documented (Bridgstock, 2009:32; Hinchcliffe & Jolly, 2011:563; Oliver, 2011:9; Yorke, 2006:8).

This study uses the term ‘graduate capabilities’ (Oliver, 2011:7) to capture the generic graduate attributes and the ‘specific graduate attributes’ associated with the knowledge, skills, competencies and attributes required to be effective and successful within the discipline, profession or vocation. This implies that graduate capabilities are synonymous with ‘combined graduate attributes’ as defined by
Griesel and Parker (2009:5). In the broader sense, graduate capabilities describe what it means to be a graduate (Barrie, 2004:261; Hill et al., 2016:156).

Facilitating the development of graduate capabilities aims to transform graduates to become unique global citizens who meet the requirements of the communities in which they function (Barnett, 2006:51; Bond, Sproken-Smith, McLean, Smith, Frielick, Jenkins & Marshall, 2017:43; Chetty, 2012:1; Glover et al., 2002:304; Harwood, 2010:414). Barrie (2004:261) offers a research-based approach to graduate capabilities which emphasises scholarship, citizenship and life-long learning as essential elements. The value seen in life-long learning is that it empowers graduates to continuously upskill and update their expertise and ability in their chosen disciplines. Graduates can thus remain adaptable, innovative and up-to-date in the workplace (Batchelor, 2008:46; CBI & UUK, 2009:5; Collet et al., 2015:546). Moreover, it will allow graduates to adapt to an ‘unknown future’ (Barnett, 2006:54; Bowden et al., 2000:3; Ismail, 2017:1).

To provide stakeholders with graduates that meet their needs, it is important to base research on sound theoretical principles and to gather perspectives from as many relevant stakeholders as possible. Using a survey engages the relevant stakeholders in the process of identifying the knowledge, skills, attributes and competencies required to optimally meet their needs (Bentley, Richardson, Duan, Philpott, Ong & Owen, 2013:652; CBI, 2010:5). The reviewed literature formed the basis of the theoretical framework for the questionnaire developed for this study.

Figure 2.2 captures the complexity and interrelated concepts and themes associated with graduate capabilities.

2.3 GRADUATE CAPABILITIES

This section describes each of the interconnected concepts and themes that form the graduate capabilities as shown in Figure 2.2. Firstly, generic graduate attributes, including employability skills and graduateness, and personal attributes are described.
2.3.1 Generic graduate attributes

In this study, skills required from all graduates of higher education are referred to as ‘generic graduate attributes’ (Andrews & Higson, 2008:413; Bohlscheid & Clarke, 2012:8; Coetzee, 2014:80; Daniels & Brooker, 2014:66; Hooker & Whistance, 2016:156). This is motivated by the fact that the term ‘generic graduate attributes’ is generally used in Australia (Barrie, 2004:262; Oliver, 2011:2) and South Africa (Griesel & Parker, 2009:5). ‘Generic’ implies that these are the attributes of graduates that are developed regardless and independently of the discipline of study (Barrie, 2004:262). Generic graduate attributes include skills that are transferable outside the discipline (Yorke, 2006:2) and to various situations (Nägele & Stalder, 2017:793). Generic graduate attributes are often associated with employability skills, and are described in literature as non-specific, universal and transportable skills relevant to many areas of life other than employment (Andrews & Higson, 2008:411; Bohlscheid & Clark, 2012:8; CBI, 2010:3; Griesel & Parker, 2009:5-6; Lowden et al., 2011:4; Oliver, 2011:2-4; Pegg et al., 2012:5; Steur et al., 2012:864; Yorke, 2006:8). However, rather than emphasising employability, Cleary et al. (2007:12) and Bowden et al. (2000:3) refer to the social, ethical and humanitarian characteristics needed by the community. These sentiments are reaffirmed in Table 2.1.
Table 2.1: Generic graduate attributes: definitions and descriptions

<table>
<thead>
<tr>
<th>Author/source</th>
<th>Definition, description and/or characteristics of graduate attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Higher Education Council (HEC), 1992:20</td>
<td>“Skills, personal attributes and values which should be acquired by all graduates regardless of their discipline or field of study” (italics added)</td>
</tr>
<tr>
<td>Australian Qualifications Council, 2013:95</td>
<td>“Transferable, non-discipline specific skills a graduate may achieve through learning that have application in study, work and life contexts” (italics added)</td>
</tr>
<tr>
<td>Barnett, 2006:64</td>
<td>“Capabilities, qualities and dispositions that constitute a personal infrastructure that makes possible an individual and authentic space…”</td>
</tr>
<tr>
<td>Barrie, 2004:262</td>
<td>“Skills, knowledge and abilities of university graduates, beyond disciplinary content knowledge, which are applicable to a range of contexts” (italics added)</td>
</tr>
</tbody>
</table>
| Bowden et al., 2000:3 | “Qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution…”  
“The qualities, skills and understandings [that] include but go beyond the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future” (italics added) |
| Cleary et al., 2007:12 | “Reflect broader aspirational, social, ethical or humanitarian characteristics that a society desires of its university graduates.” |
| Griesel & Parker, 2009:5 | “Knowledge, skills, competencies and values of new graduates… necessary as a pre-condition…to have achieved employability” (italics added) |

Hence, generic graduate attributes can be broadly defined under two distinct categories, namely:

- The skills, abilities or capabilities that pertain to the graduate’s ability to obtain and be effective in employment in their chosen discipline or profession. These are broadly described as *employability skills* (Barrie, 2004:262; Chetty, 2012:1; Yorke & Knight, 2006:3).
- The characteristics of scholarship and life-long learning; it includes personal qualities, attitudes and dispositions that develop students’ citizenship and are broadly described as *graduateness* (Barnett, 2006:51; Barrie, 2004:263; Bowden et al., 2000:3; Chetty, 2012:1).

The role of higher education in developing adaptable and employable graduates capable of meeting the needs of the community through generic graduate attributes is well documented and often captured through regional, national and/or institutional policies (Archer & Chetty, 2013:134; Barrie, 2004:263; Barrie et al., 2009:2; Cleary et
al., 2007:12; Holmes, 2013:1044; Oliver, 2011:6). However, there are countries who do not prescribe to the notion of generic graduate attributes in policy statements; consequently, facilitating the development of graduate attributes have received little attention. This is largely the case in South Africa, and, as a result, there is a growing need to address this issue at a national level (Bezuidenhout, 2011:3; Coetzee, 2012b:26). Despite this shortcoming, some South African universities have developed institutional policies in line with the vision and mission of the institution for embedding and developing graduate attributes (Stellenbosch University (SU), 2017; University of the Western Cape (UWC), 2012).

Generic graduate attributes are generally recognised to include communication and numeracy skills, working in a team, problem identification and problem-solving skills, creativity and innovative skills, technology skills such as computer literacy, planning and organisational skills, and life-long learning skills (CBI & UUK, 2009:5). As employers often consider generic graduate attributes as more important than disciplinary knowledge (Griesel & Parker, 2009:5; Oliver, 2011:11; Yorke, 2006:8), the questionnaire developed for this study probed the priorities, importance and relevance of generic graduate attributes, especially with relevance to food science and technology graduates. The themes identified through the literature formed the basis for the content of this section of the questionnaire probing generic graduate attributes.

The literature reviewed reinforced that the theme of employability, the concept of graduateness associated with scholarship, citizenship and life-long learning, and the desirable personal attributes are essential aspects of a graduate (Andrews & Higson, 2008:411; Barrie, 2004:262; Yorke, 2006:14; Yorke & Knight, 2006:4). This supports the view that generic graduate attributes are a complex network of interdependent behavioural and cognitive characteristics that are outcomes that exceed disciplinary outcomes (Barrie, 2004:262). Furthermore, the literature pertinent to employability, graduateness and personal attributes also identified themes pertinent to the questionnaire used in the situation analysis of this study (refer to Annexure B).
2.3.1.1 Employability skills and the concept of graduateness

As with graduate capabilities and graduate attributes, the concepts of employability and graduateness are elusive and difficult to describe (Andrews & Higson, 2008:413; Knight & Yorke, 2004:263; Lowden et al., 2011:4; Steur et al., 2012:861). Many of the definitions proposed for ‘graduateness’ and ‘employability’ do not make a clear distinction between the two (Lowden et al., 2011:4), although several authors agree that they are associated with ‘generic graduate attributes’ (Knight & Yorke, 2004:263; Steur et al., 2012:861). Nonetheless, both graduateness and employability are desired outcomes of higher education (Cai, 2012:1; Griesel & Parker, 2009:8; Knight & Yorke, 2004:263; Litchfield et al., 2010:519). On the one hand, ‘employability’ skills promote that graduates must be capable of “doing things rather than reciting propositional knowledge” (Halliday, 2004:579). On the other hand, ‘graduateness’ refers to qualities that cannot be attributed to discipline-specific knowledge and technical skills, or to generic transferable skills. Rather, ‘graduateness’ refers to attitudes and beliefs that are influenced by the inherent characteristics of the person that can be further enhanced during undergraduate studies (Barnett, 2004:247; Chetty, 2012:3; Glover et al., 2002:295, 303).

Some authors consider ‘graduateness’ and ‘employability’ as outcomes of a binary system of higher education, with ‘graduateness’ being a product of traditional academic higher education and ‘employability’ a product of vocational and professional higher education (Campbell & Rozsnyai, 2002:32; Gowdy, 1994:363; Teichler, 2003:174). Other authors consider graduateness and employability as closely related, synergistic and the two sides of a coin rather than separate concepts (Barnett, 2004:49; Steur et al., 2012:872). Within the South African context, the philosophical and practical aspects of graduateness and employability are increasingly interrogated (Chetty, 2012:5; Griesel & Parker, 2009:7), and it is suggested that employability is a sub-concept of graduateness (Coetzee, 2012a:120).

It follows that the concepts of graduateness and employability are different but entwined, in that work-ready graduates must exhibit graduateness (Steur et al., 2012:864, 872) and autonomy (Coorey & Firth, 2013:21) to be successful in
employment. The ideal graduate of the 21st century should be academically and professionally holistic and well-rounded to be of optimal benefit to societal stakeholders (Ismail, 2017:9; Quinlan, 2011:5). More importantly, graduates must be dedicated to continuous life-long learning to keep pace with the knowledge generation and the rapid changes in technology in the modern workplace (Barnett, 2004:54; Bull, 2010:14; Coetzee, 2014:890; Pool & Sewell, 2007:277). Furthermore, graduates can no longer expect to have traditional careers within one organisation; they must be able and prepared to shift between organisations (Akkermans et al., 2012:246). Career flexibility and adaptability require that graduates continually enhance their employability and, in doing so, actively manage their careers (Bridgstock, 2009:31). Career competencies are defined by Akkermans et al. (102:246) as “knowledge, skills, and abilities central to career development, which can be influenced and developed by the individual”.

a) Employability skills

Employability can be viewed differently depending on the needs and expectations of diverse societal stakeholders such as government, higher education intuitions, employers and students (Atress et al., 2017:6). Employability in the context of this study focusses on producing graduates who are sought after by potential employers and it is an essential outcome of higher education. According to Hillage and Pollard (1998:83), employability is the ability to:

• gain initial employment;
• maintain employment and make ‘transitions’ between jobs and roles within the same organisation to meet new job requirements; and
• obtain new employment if required, to be independent in the labour market by being willing and able to manage employment transitions between and within organisations.

However, employability skills are not only about equipping people for employability within the workplace but also to achieve personal fulfilment (Bloom & Kitagawa,
Furthermore, employability is a priority to address youth employment (UN, 2001:6).

Employability and work readiness are increasingly reflected in higher education policies as a basic role of higher education (Cai, 2012:1; Griesel & Parker, 2009:8; Pegg et al., 2012:12; Small, Shacklock & Marchant, 2018:148). However, this view is challenged by Glover et al. (2002:303) and Yorke (2006:2) who suggest that although higher education can play a part in facilitating the development of employability, practical skills and attributes are more successfully developed through vocational training and the workplace than through higher education. Yorke (2006:2) recommends that work placements or work-integrated learning may be useful in this regard, a view supported by Jackson (2015:350). Regardless, the meaning of employability in higher education is elusive and complex (Rae, 2007:605) and has been defined both narrowly and more broadly by many authors.

Narrow definitions of employability tend to focus on the generic characteristics and skills of an individual, while broader definitions extend to personal attributes. Narrow definitions of employability in terms of skills and attributes have been promoted by government educational initiatives and policies, for example in Australia (Bridgstock, 2009:33) and the UK (Yorke, 2010:1). In the narrow context, employability refers to generic skills and attributes that are viewed as having immediate benefits for society, the graduate and the workplace (Bezuidenhout, 2011:3; Pegg et al., 2012:5; Steur et al., 2012:862). It also seems that narrow definitions of employability require “employability statements” (Pegg et al., 2012:12) or a “set of achievements” that Yorke (2004:410) observes as necessary but not sufficient to gain employment. This suggests that employability skills may be insufficient to be successful in employment, as the required skills are not static and need to be continually developed (Yorke, 2004:410; Yorke & Knight, 2006:4), thus contributing to career adaptability (Ismail, 2017:1). Furthermore, narrow definitions of employability have also resulted in much research into ‘missing’ employability skills to identify the gap between what employers expect and what graduates demonstrate when they take up employment (Pegg et al., 2012:19).
More recently, the simplistic view of employability as a set of skills has been recognised as being inadequate to capture the broader and complex nature of employability. In trying to capture the aspects of gaining and being successful in employment, Yorke and Knight (2006:3) provide an often-quoted broader definition of employability (refer to 1.3.3.6) that includes the ‘skills, understandings and personal attributes’ that will support a graduate to gain and be successful in employment. Broader definitions of employability are evident in the United States of America (USA) (Steur et al., 2012:862) and South Africa (Griesel & Parker, 2009:6; SA CHE, 2011:1), where employability includes personal attributes such as attitudes, ethics and values. Other definitions of employability capture the aspect of life-long learning required of graduates to remain employable (Pool & Sewell, 2007:277; Glover et al., 2002:294; Harvey, 2003:Defining employability). Harvey and Knight (2003:4) propose that the attributes that will assist a graduate in obtaining, retaining and being successful within a job are captured by the term ‘employability’. In defining employability more broadly, Pool and Sewell (2007:180) include the aspect of graduate satisfaction and success within their career path. However, graduate satisfaction and success is largely outside of the control of higher education (Hillage & Pollard, 1998:2), as it is influenced by the graduates’ ability to make the most of their graduate capabilities, including their employability skills. Besides, graduate satisfaction and success may be influenced by the graduate’s individual situation and external economic and labour factors (McQuaid & Lindsay, 2005:213). McQuaid and Lindsay (2005:199) propose that the impact of the economic and labour market conditions must be considered to provide a more holistic view of employability. Economic and labour market conditions are acknowledged as crucial to employability but are outside the scope of this study and are not further discussed.

Additionally, rating agencies view employability as a performance indicator of higher education institutions (Balta, Coughlan & Hobson, 2012:399). Employability indicators include aspects such as the length of time it takes a graduate to obtain employment after graduating. An example of this is the UK’s ‘first destination project’ which measures employment statistics six months after graduating (Gracia, 2009:301). However, the availability of meaningful employment, the nature of the labour market, and economic factors may influence employment statistics (Bridgstock, 2009:33; CBI & UUK, 2009:13). Other factors outside the control of
higher education institutions include the type of qualification of the graduate, the geographical area in which the graduate desires employment, and the employer’s choice of an appropriate candidate (Andrews & Higson, 2008:413). Employability in this context is beyond the scope of this study and is not further discussed.

The intention of this study is not to debate the numerous definitions of employability (Kruger, 2014:24-26), or to formulate an alternate definition, but rather to identify what is required of graduates to demonstrate employability (Lowden et al., 2012:iv) and to interrogate how employability can be enhanced during undergraduate studies (Gruber-Muecke, Kailer Grabner & Stoegmueller, 2010:73). By synthesising available literature, Andrews and Higson (2008:413) identified a list of key skills and competencies required to demonstrate graduate employability. These skills and competencies include:

- Professionalism
- Reliability
- Ability to cope with uncertainty
- Ability to work under pressure
- Ability to plan and think strategically
- Ability to communicate and interact with others, either in teams or through networking
- Written and verbal communication skills
- Information and communication technology skills
- Creativity and self-confidence
- Self-management and time-management skills
- Willingness to learn and accept responsibility

Al-Alawneh (2009:137), in developing a questionnaire to measure employers’ perceptions of graduates’ employability skills, included three employability domains, namely fundamental skills such as communication skills and computer literacy, personal management skills such as ethical behaviour and honesty, and teamwork skills.
Similarly, many models and frameworks have been proposed for employability. The USEM Model of Employability (Yorke & Knight, 2006:5) is one such model and represents four components, namely:

- **Understanding**, including disciplinary-specific knowledge
- **Skilful** practices, including academic, employment and life skills
- **Efficacy** beliefs reflecting the concepts of self and self-belief, and the ability to self-develop through life-long learning
- **Metacognition** embracing efficacy, self-awareness, and how to learn

The USEM employability model acknowledges the needs of stakeholders, including students and employers, and provides a framework for embedding employability into the curriculum. What sets the USEM model apart from earlier models, is that it was developed based on empirical evidence and relates to the capabilities demonstrated by the graduate. These capabilities can be equated to the interconnected aspects of graduate capabilities proposed by this study (refer to Figure 2.2) and allow the graduate to respond to changing circumstances (Brewer, Flavell, Davis, Harris & Bathgate, 2014:31). The USEM model proposes the interrelatedness of the four proposed aspects of employability, as is shown in Figure 2.3.

![Figure 2.3: The USEM model of employability (adapted from Yorke & Knight, 2006:5)]
Including the attributes of efficacy beliefs and metacognition in the model introduces the concept of personal attributes, including qualities, attitudes and dispositions which are associated with the concept of graduateness (see 2.3.1.2). Efficacy or self-efficacy is the ability to perform across diverse situations, and career-related self-efficacy is proposed to be a basis for effective career self-management (Akkermans, et al., 2012:250). Bates, Thompson and Bates (2013:21) propose self-efficacy behaviours to include displaying teamwork, expressing sensitivity, dealing with politics and managing stress. In contrast, metacognition is the complex ability to be aware, select, monitor, manage and reflect on what one knows and can do (Knight & Yorke, 2002:266; National Research Council, 2012:6-20). Metacognition is central to solving problems and engaging in self-directed learning and developing the metacognition of students through appropriate teaching approaches leads to more flexible and malleable students who can engage in lifelong learning (Knight & Yorke, 2002:266; National Research Council, 2012:6-20).

The model of Yorke and Knight (2006:8) suggests that discipline-specific knowledge and skills are assumed, and they recommend 39 employability skills that may assist in embedding employability skills into the curriculum of higher education programmes. Yorke and Knight (2006:8) loosely group this list of employability skills into three categories, namely:

- personal qualities such as self-awareness and self-confidence;
- core skills such as communication and numeracy; and
- process skills such as prioritising and planning.

There are overlaps between some of the listed employability skills in the sense that some may not be relevant in certain contexts, and others could fit into more than one category. However, the list is comprehensive and was used as a source when drafting the sections of the questionnaire developed for this study dealing with employability skills and personal attributes.

An alternative model, the ‘CareerEDGE Key to Employability Model’ of Pool and Sewell (2007:282), was proposed as a simplified alternative to the USEM model. This
model (Pool & Sewell, 2007:282) captures all the elements of the USEM Model, and in addition describes the necessary disciplinary knowledge, skills and understanding as central to the model. The personal attributes of efficacy beliefs and metacognition captured by the USEM model are further enhanced by the inclusion of the narrower concept of emotional intelligence, as well as the inclusion of the ability to reflect and evaluate in order to facilitate the required transformation and development of a valid self-identity (Barnett, 2004:248; Hinchliffe & Jolly, 2011:564; Pool & Sewell, 2007:282). The five essential components of employability identified by this model are shown in Figure 2.4 (adapted from Pool & Sewell, 2007:282).

**Figure 2.4: CareerEDGE Key to Employability Model**

In summary, the definition of employability of Yorke and Knight (2006:3) adopted for this study, and the presented employability models, suggest that employability skills are those generic graduate attributes associated with employability, but which cannot be separated from the concept of graduateness. So entangled are the two concepts with generic graduate attributes that the attainment of employability attributes is proposed to influence the development of graduateness (Coetzee & Potgieter, 2012:2). Employability and graduateness, rather than being viewed as sub-components of the generic graduate attributes, are viewed in this study as distinct but interconnected aspects of a graduate who demonstrates graduate capabilities (refer to Figure 2.2) that are required to be successful in employment (Barrie, 2004:261; Yorke, 2004:410). The importance of personal attributes, including dispositions and...
beliefs (Barnett, 2009:434), is also highlighted as an essential factor to the enhancement of employability and graduateness.

b) Graduateness

Attempts to suitably define graduateness has been ongoing since the advent of higher education and will continue because graduateness is forever-changing (Steur et al., 2012:863). Graduateness deals with the transformation and development of human qualities through intellectual growth and is considered a fundamental outcome of higher education and common to all graduates (Barnett, 2006:49; Barrie, 2004:261; Coetzee & Potgieter, 2012:2; Steur et al., 2012:862). Glover et al. (2002:294) define ‘graduateness’ as the “effect on knowledge, skills and attitudes of having undertaken an undergraduate degree” (emphasis added). Most importantly, graduateness is considered as personal growth and is distinct from discipline or degree-specific knowledge, skills and competencies (Coetzee, 2012a:120; Coetzee, 2014:888). Through graduateness, the intellectual development of a student is encouraged, enabling them to have a set of generic capabilities, rather than adopting too strong a focus on vocational and/or professional knowledge (Steur et al., 2012:863). Considering this, graduateness describes the development of the graduate’s personal character or ontological disposition and his or her way of thinking or acting. Thus, graduateness is a complex concept that captures knowledge of the world and of the self, and engages students to find their individual identity (Hinchliffe & Jolly, 2011:564). In fact, Glover et al. (2002:303) propose that graduateness is synonymous with the term “graduate identity”.

Graduateness is associated with intellectual development and transformation, rather than with only demonstrating generic graduate attributes which would render it a meaningless concept (Glover et al., 2002:303; Steur et al., 2012:863). The characteristics of graduateness allow graduates to adapt to the continuously changing work environment by enhancing attributes such as critical thinking, problem-solving and the ability to engage in life-long learning (Barnett, 2006:64; Barrie, 2006:216; Walsh & Kotzee, 2010:36). This suggests that graduateness could be seen in contrast to employability (Glover et al., 2002:294; Steur et al., 2012:864; Walsh & Kotzee, 2010:36). Coetzee and Potgieter (2012:3) suggest that
Graduateness is a strong indicator of employability and based on this premise, propose that employability is a subcomponent of graduateness.

In attempting to describe graduateness, Coetzee (2012a:120) submits that graduateness comprises three interconnecting domains of individual and scholarly development as shown in Figure 2.5. The first domain is scholarship and students’ attitude towards new information and the ability to appropriately apply information to situations; second is citizenship and students’ attitude, ethical stance and contribution towards their chosen profession/vocation and local, national and global communities; and third, the ability to engage in life-long learning (Coetzee, 2014:888-890).

Figure 2.5: Domains of graduateness (adapted from Coetzee, 2014:888-890)

Glover et al. (2002:303) support the domains of graduateness proposed by Coetzee (2012a:120; 2014:888-890) and further propose that graduates of higher education can be distinguished from non-graduates in the sense that they show scholarship, citizenship, and they can adapt to change. In terms of this study, graduateness is viewed as separate but intertwined with generic graduate attributes, and is a vital aspect of the graduate capabilities (refer to Figure 2.2) required to meet the expectations of societal stakeholders.

2.3.2 Personal attributes

Knight and Yorke (2002:261) define graduate employability as “understandings, skills and personal capabilities necessary to perform adequately in a graduate-level job”
(emphasis added). Pandit et al., (2015:303) associate positive personal attributes with successful employability and go so far as to suggest that they “distinguish an employable person”. Further to this, Flint-Taylor, Dayda and Cooper (2014:3) comment that “the most stable and enduring personal capabilities tend to be categorised in terms of [intellectual] ability and personality”; they also mentioned the role of personal capabilities in contributing to work resilience and successful career management.

Personal attributes are the attributes associated with personal characteristics, qualities and attitudes (Bull, 2010:23; Chipchase et al., 2012:9). Personal attributes can be categorised as dispositions and qualities and can be viewed as “epistemic virtues” that nurture “certain ethically worthwhile forms of human being” (Barnett, 2009:434). There are many lists of desirable personal attributes, qualities and characteristics that are considered important to employability (Andrews & Higson, 2008:411; Artess et al., 2017:17; Barnett, 2006:49; Sewell & Pool, 2010:91). Hill et al., (2016:156) capture the personal attributes that are important to a graduate as:

Self-awareness, self-confidence, personal autonomy/self-reliance, flexibility and creativity; and personal values such as ethical, moral and social responsibility, integrity, and cross-cultural awareness.

An employability skills framework developed in Australia defines personal attributes as non-skill attitudes and behaviours that employers consider important to employability and the ability to do the job (AU DEST, 2002:38). The employability skills framework identifies the following personal attributes as important to employability: loyalty; personal presentation; a balanced attitude to work and home life; commitment; common-sense; ability to deal with pressure; honesty and integrity; positive self-esteem; motivation; enthusiasm; a sense of humour; adaptability; and reliability.

Barnett (2009:433) distinguishes between personal dispositions such as willingness, preparedness and determination, and personal qualities such as “courage, resilience, carefulness, integrity, self-discipline, restraint, respect for others, openness, generosity, authenticity”. Dispositions are ‘fundamental’ and allow individuals to
engage with the world around them to ‘be and become’, while qualities are suggested to be the manifestation of dispositions and are the ‘character’ of the individual (Barnett, 2009:434). However, both dispositions and qualities are implicated in teaching and learning and how the student assimilates and interacts with knowledge to develop ‘understanding’ – that is, there is a relationship between knowledge and ‘being’. Furthermore, Barnett (2009:435) proposes that although there are long lists available of the personal attributes required of graduates in general, ultimately the discipline of study will dictate the specific mix and weight of dispositions and qualities needed to meet the requirements of the occupation, vocation or profession.

Undeniably, generic graduate attributes and the concepts of graduateness and employability are intimately associated with personal or individual attributes, many of which are related to the personality traits of the graduate (Chetty, 2012:14; Coetzee, 2012a:120). In fact, some employers voice the opinion that they value the personal attributes associated with the graduate more highly than either their discipline-specific capabilities or their generic employability skills and capabilities (Chipchase et al., 2012:9). A range of personal attributes, including capabilities, temperaments, dispositions, and beliefs are recognised to play a central role in preparing graduates to work productively without further development by the employer (Chetty, 2012:14). Pandit et al. (2015:303) suggest that the person or “agentic self”, together with the prevailing socio-economic and labour factors of the environment, represent the “duality” of employability when viewed through a sociological lens.

In developing guidelines for the personal attributes required of financial planners in Australia and New Zealand, Birkett (1996:10) divided personal attributes into two domains, namely cognitive, and behavioural skills (refer to Figure 2.6).
Several authors have supported the notion that both cognitive and behavioural skills are necessary for employability (Birkett, 1996:10; Jackling & Sullivan, 2007:211; Pegg et al., 2012:30). Cognitive skills are defined to include technical skills and characteristics such as problem-solving and strategic thinking (Al-Alawneh, 2009:34; Birkett, 1996:10). In contrast, behavioural skills include personal skills such as a positive attitude, determination, perseverance, adaptability and ethical behaviour (Barnett, 2009:434), interpersonal skills such as communication, and organisational skills (Al-Alawneh, 2009:34; Birkett, 1996:10; Jackling & Sullivan, 2007:211).

Tymon (2013:845) observes that many of the personal attributes required by employers are skills that can be developed, either through the intervention of higher education or exposure to the workplace. Higher education is recognised to develop and enhance epistemic virtues (Barnett, 2009:434), and develop the ‘proactive’ personality of graduates to enhance their initiative and adaptability (Fugate, Kinicki & Ashforth, 2004:13; Fuller & Marler, 2009:329; Rae, 2007:607). However, employers are often also looking for specific personality traits. Unlike skills, personality traits such as a positive attitude are as unique to the individual as their intellectual abilities. The extent to which personality traits can be developed is questionable, and if it is indeed possible, it would be a long-term process (Tymon, 2013:846). Desired personality
traits can be described by the phrase ‘proactive personality’ (Fugate et al., 2004:13). Proactive personality traits allow for easier adaptability to changing circumstances, and therefore aid in securing employment and career success (Fuller & Marler, 2009:329). Proactive adaptability is suggested to have three dimensions, namely “career identity; personal adaptability; and social and human capital” (Fugate et al., 2004:13). The role of higher education in developing proactive traits may be limited. However, it is proposed that the graduate’s unique identity and personality can be transformed during the experience of higher education (Rae, 2007:607) through adopting student-driven teaching and learning practices (Tymon, 2013:846, 853).

In the context of this study, personal attributes are essential and integrated with all aspects of graduate capabilities; they especially impact on employability and graduateness. As such, personal attributes identified through literature as required of graduates in general, and more specifically from food scientists and technologists, were included in the questionnaire developed for this study.

2.3.3 Food science and technology-specific knowledge, skills and capabilities

Food science and technology has been introduced as a multi-disciplinary, science-based field of study that has a crucial role to play in ensuring enough nutritious food of the correct quality and safety to meet the needs of the global community (see 1.1.4). Food scientists and technologists need diverse knowledge, skills and competencies which include generic ‘intuitive’ skills and discipline-specific scientific and technical knowledge, skills and competencies (Flynn, Ho, Vieira, Pittia & Rosa, 2017:129). This section aims to provide an overview of the fundamental food science and technology knowledge, skills and competencies or ‘specific graduate attributes’, that may be applicable to undergraduate programmes in food science and technology as identified through literature (Bohlscheid & Clarke, 2012:8; Floros et al., 2010:572; Flynn et al., 2013:247; IFT, 2011:7; Johnston, Wiedemann, Orta-Ramirez, Oliver, Nightingale, Moore, Stevenson & Jaykus, 2014:18-9). The food science and technology-specific graduate attributes, in addition to the ‘generic graduate attributes’ (refer to 2.2.3.1), associated employability skills (refer to 2.2.3.2 a) and characteristics of graduateness (see 2.2.3.2 b), are the ‘graduate capabilities’ required of food scientists and technologists.
Several studies have been conducted to identify the knowledge, skills and competencies required by the food and allied manufacturing sectors. Many had the purpose of identifying existing and potential skills deficiencies rather than the graduate capabilities required of food scientists and technologists. One such study was conducted to identify the fundamental and more specific skills required in the food and beverage subsectors of Ireland (Expert Group on Future Skills Needs, 2009:6):

- producing, processing and preserving meat and meat products;
- processing and preserving fish and fish products;
- processing and preserving fruit and vegetables;
- manufacturing vegetable and animal oils and fats;
- manufacturing dairy products;
- manufacturing grain mill products, starches and starch products;
- manufacturing prepared animal feeds;
- manufacturing other food products; and
- manufacturing beverages.

Another such study conducted in the EU was the “Training Requirements and Careers for Knowledge-based Food Science and/or Technology in Europe Project”, or TRACK_FAST project. This project aimed to identify the training and career requirements of food scientists and technologists within the EU (Flynn et al., 2013:246; Ho et al., 2011). As a starting point for the TRACK_FAST project, Ho et al., (2011:1) developed knowledge, skills and learning outcomes for careers in the food industry based on two sources. The first was a study conducted by the Conference Board of Canada that formulated the ‘generic skills, attitudes and behaviours’ required to contribute and progress in the workplace in general, rather than those specific to food scientists and technologists (Bloom & Kitagawa, 1999:1). The second source was a draft report by the United Kingdom Sector Skills Agency for food and drink manufacturers of the skills required by the food industry within the UK (Ho et al., 2011:1). Ho et al. (2011:3) divided the skills identified by these two sources into three sections which were further divided into categories and sub-categories with their associated learning outcomes.
The first section examined the fundamental generic skills that are common to employability in general, and included five categories (Bloom & Kitagawa, 1999:6), namely:

- Fundamental skills
- Personal management skills
- Teamworking and interpersonal skills
- Business skills
- Pedagogical skills

The second section outlined the knowledge, understanding, and skills specific to the food industry in general, and included the categories (Ho et al., 2011:2-8):

- Food quality and food safety skills
- Food-related research and development
- Food manufacturing and production skills
- Skills related to food retail, the supply chain and logistics

The last section identified skills that were specific to certain sectors of the food industry, such as (Ho et al., 2011:9-11):

- Meat and poultry processing
- Fish and shellfish processing
- Production of dairy products
- Production and packaging of beer to name a few

Figure 2.7 provides an overview of the contents of each section.
Together with the findings of another study in the TRACK_FAST project which examined the knowledge and skills required of the food and allied industries within the EU (Flynn et al., 2013:247), the sections, categories, sub-categories and associated learning outcomes of Ho et al. (2011:9-11, refer to Figure 2.7) were considered and included in drafting the questionnaire for this study. Correspondingly, the draft questionnaire was divided into sections as proposed by Ho et al. (2011:9-11, refer to Figure 2.7).

As part of the TRACK_FAST project, Flynn et al. (2013:247) conducted several workshops with employers from 16 countries across Europe to brainstorm the possible skills desired of food scientists and technologists in the EU. A total of 3,348 general skills were identified through these workshops. These skills were then clustered into skill categories, according to Ho et al. (2011:1-11). Each skill was then associated with a level of employment according to responsibility or job profiles, the
employment sector within the food and allied industries, and the country or geographical area within the EU. The relative importance of the skills was ranked according to the number of times a skill was acknowledged by the participants; overall communication was reported as the most identified skill (Flynn et al., 2013:253). Of the 792 food sector skills provided by the participants, food product development was identified as the most desired skill (Flynn et al., 2013:254).

Another such study, also conducted in the EU, identified the food manufacturing job-specific technical competencies required for specific job roles (Jassi, Hart, Bayliss, Pappadà, Magni & Ghignoni, 2013:121-241). The job-specific competencies categorise the knowledge, understanding, skills, abilities, education, training and work experience required to competently perform specific jobs (Jassi et al., 2013:121-241). The report includes an extensive literature review which highlights good practice around employability in the food and beverage industry and suggests possible “up-skilling measures” (Jassi et al., 2013:44). This report was located and scrutinised only after the draft questionnaire was developed, and it was primarily used to confirm the content of the final questionnaire.

The importance of different subsectors of the food and allied sector in South Africa – in which more specific skill requirements and/or specific applications of fundamental knowledge, skills and competencies may be expected – was developed based on the subsectors proposed by Ho et al. (2011:9-11, refer to Figure 2.7). The Expert Group on Future Skills Needs (2009:6) and other literature pertinent to the agricultural, food and allied sector in South Africa was also incorporated (Harcourt, 2011:14-44; Igumbor, Sanders, Puoane, Tsolekile, Schwarz, Purdy, Swart, Durão & Hawkes, 2012:2-3; SA DAFF, 2017a:11-77; SA DAFF, 2017b:1). After consolidation and confirmation by the focus group discussion findings, the following subsectors were reflected in the finalised questionnaire: fresh and processed meat products; fresh and processed poultry products; fresh and processed fish and fish products; fresh and processed fruit and vegetables; vegetable and animal fats and oils; milk and milk products; dairy products; grain mill products; starches and starch products; prepared animal feeds; baked wheat flour products including baked bread, confectionery and snacks; sugar and sugar confectionery; cocoa and chocolate manufacture; pasta, couscous and similar products; snack products other than baked wheat flour snacks;
tea, coffee and hot beverages such as hot chocolate; distilled spirit products and liqueurs; wine products; malt, malt liquors and malt beers; and soft drinks and mineral water, both carbonated and still.

In addition to the reviewed literature, educational guidelines provided by several food science and technology organisations were scrutinised to identify academic and technical knowledge, skills and competencies generally expected from these graduates. In some cases, these organisations, in addition to educational guidelines, provide criteria against which food science and technology education programmes and/or qualifications can apply for accreditation or recognition. The criteria provided for accreditation were also used as input into the questionnaire developed for this study.

2.3.3.1 Institute of Food Technologists – United States of America

To enhance the equivalence and standing of undergraduate food science and technology qualifications in the USA and globally, the IFT, based in Chicago, developed minimum education standards or “Core Competencies in Food Science” (IFT, 2011:6-8). These educational standards guide the evaluation of existing programmes for approval and are a valuable resource when developing new food science and technology undergraduate programmes. These educational standards were referred to when developing the content of the draft questionnaire for this study. The ‘core competencies’ focused on two areas, namely the ‘success skills’ and core food science and technology learning outcomes (refer to Figure 2.8). The ‘success skills’ or generic attributes must be developed within the context of food science and technology education to ensure relevance and must be incorporated across the courses in the educational programme.
Figure 2.8: The IFT 2011 Core Competencies in Food Science (IFT, 2011:6-8)

In addition to the four broad core competencies of food science and technology discipline-specific knowledge, skills and competencies (refer to Figure 2.8), the required prerequisite basic knowledge, including chemistry, biology, general microbiology, human nutrition, physics, mathematics and statistics, is outlined (IFT, 2011:5). A brief description of the required content and minimum learning outcomes for each of the core competencies is also provided (IFT, 2011:6-8). The resource document was revised in March 2016 and again in January 2019. In the 2019 revision, the IFT programme requirements and the minimum required food science and technology standards are updated as shown in Figure 2.9.

The latest revision increases the food science and technology ‘core competencies’ areas from four to seven, splitting food microbiology from food safety and adding the areas of sensory science, quality assurance and food laws and regulations. Data and statistical analysis are added to the ‘success skills’ and five of the previously required skills are combined as ‘professionalism and leadership’ skills.
At present, there are several undergraduate programmes approved by the IFT in the USA and globally. However, there are presently no South African programmes approved by this organisation. Approval of existing South African programmes against these minimum educational standards will promote international recognition and globalisation. However, the applicability of these standards in the South African context has not been determined (see research sub-question 2).

a) Certification for food professionals

The IFT introduced a global certification for food professionals in 2013. The International Food Science Certification Commission (IFSCC) of the institute manages the ‘Certified Food Scientist®’ or CFS initiative. This certification, based on an examination, recognises applied food science and technology scientific knowledge and skills, and is the only such certification initiative available globally. Candidates wishing to be certified apply to sit the certification examination based on their higher education qualification/s in food science or a related discipline, together with a minimum period of work experience. The certification examination consists of 120 multiple choice questions covering the fundamental knowledge and skills that food professionals apply in their jobs. The examination content was prepared through a methodical job-task analysis, followed by validation through a survey of a targeted, representative sample of food scientists (IFT, 2018:1). The content covers the following areas and content weightings:
• Food product development (34%)
• Quality assurance and control (17%)
• Food chemistry and analysis (10%)
• Regulatory knowledge (10%)
• Food microbiology (9%)
• Food safety (9%)
• Food engineering (6%)
• Sensory evaluation and consumer testing (5%)

Maintaining certification requires evidence of a minimum of 75 contact hours of approved continuous learning activities every five years. The resource material, which provides learning outcomes required for each area, was located after the survey was developed and deployed. Consequently, it was not used as a resource when developing the survey but was used to corroborate the content of the survey when analysing the findings.

2.3.3.2 International Union of Food Science and Technology – Canada

The IUFoST based in Toronto, Canada, is another international organisation to which many of the geographical food science and technology organisations, such as the South African Association of Food Science and Technology, prescribe. The IUFoST webpage states that they are currently developing guidelines and minimum requirements for the curricula and “minimum learning outcomes” of food science programmes (Wirakartakusumah & Yada, 2012:1), but that these are not yet available (as at 03 February 2018). The webpage further indicates that in the interim, while minimum learning outcomes are being developed, programmes will be evaluated on an ‘ad hoc’ basis “against international best practice” (Wirakartakusumah & Yada, 2012:1). However, the organisation’s webpage does describe the requirements for ‘fundamental science: food chemistry, analysis and nutrition; food microbiology, safety and environment; and food engineering and technology’ and a minimum duration of four years (Wirakartakusumah & Yada, 2012:1). When compared to the South African Higher Education Qualification Sub-Framework (HEQSF) (SA DHET, 2012a:7; SA DHET, 2014:13) qualification types, this equates to a qualification at a National
Qualification Framework level of seven, which is considered as either postgraduate or at a professional bachelor's degree level, and which would allow direct entry into a level eight masters’ qualification. At present, the University of Stellenbosch is the only university in South Africa offering a four-year food science programme recognised by the IUFoST. Worldwide there are 18 approved programmes, including programmes in China, Indonesia, Hong Kong, Singapore, Malaysia, the Philippines, Thailand, Vietnam, Brazil and Costa Rica (Wirakartakusumah, 2017).

The organisation has also published a reference book (Campbell-Platt, 2018:1-4) which covers the core food science and technology disciplinary-elements that the organisation prescribes for higher education programmes in food science and technology. The content that the book covers is mainly food science and technology-specific, but also generic graduate attributes, including numeracy procedures, statistical analysis, information technology, and communication and ‘transferable skills’. Core food science and technology knowledge areas in the book include:

- Food chemistry
- Food analysis
- Food biochemistry
- Food biotechnology
- Food microbiology
- Food physics
- Food processing
- Food engineering
- Food packaging
- Nutrition
- Sensory evaluation
- Quality assurance and legislation
- Regulatory toxicology
- Food business management principles and practices
- Food marketing
- Product development
The food science and technology-specific areas and content presented in the book were examined to identify the food science and technology core knowledge that is recommended by the organisation, and was used as a reference when formulating the discipline-specific survey questions (refer to Table 2.2).

2.3.3.3 Institute of Food Science and Technology – United Kingdom

In a similar way, the IFST based in the UK also offers accreditation of food science and technology degrees in the UK, with plans to extend this to other countries over time. The accreditation process involves assessing applications for accreditation against eight key requirements: entry requirements for the programme; the breadth and depth of topics covered to ensure safe, quality food; development of practical skills linked to food science and technology; development of research skills; development of generic transferable skills; internal and external quality assurance; and infrastructure to support teaching and learning. In terms of discipline-specific content, the IFST requires that at least 50 percent of the qualification contact time is dedicated to food science and technology subjects such as food composition, food chemistry, food preservation and food microbiology (refer to Table 2.2 for more details). The accreditation requirements of this organisation were also scrutinised and used as input when developing the questionnaire content. In addition, the programme must meet the obligatory requirements or ‘benchmark standards’ for food science and technology programmes of the United Kingdom Quality Assurance Agency (QAA) for Higher Education (2016:10) as described next and captured in Table 2.2.

a) Quality Assurance Agency for Higher Education (QAA): United Kingdom

The Quality Assurance Agency for Higher Education is an independent non-profit organisation that aims to ensure the high standard and quality of higher education in the UK. The organisation has developed and maintains a ‘Quality Code’ for higher education that provides best practice guidelines for developing academic policies and study programmes. In addition, the organisation develops and regularly reviews ‘benchmark standards’ for various disciplines which define the mandatory knowledge, skills and abilities required to develop competency in the discipline. Unfortunately, the benchmark statement for food science and technology are brief and lack detail. The
benchmark statement requires an ‘understanding’ of chemical and physical characteristics of food ‘materials’; microbiological qualities of foods; compositional, nutritional and ‘eating’ qualities of foods; and ‘impact’ of food storage and processing on ‘human and environmental well-being’ (UK QAA, 2016:10). In addition, the benchmark statement provides six learning outcomes, namely problem-solving; innovation and commercialisation in food chains; application of research to develop new foods and processes; aspects of food safety and nutrition, ‘understanding’ legislative requirements; and minimising the harm of ‘food chain activities’ on humans and the environment (UK QAA, 2016:10).

Examination and comparison of the food-related topics proposed by the UK IFST, that include the benchmark requirements of the Quality Assurance Agency for Higher Education (2016:10), the ‘core competencies’ of the IFT (2011:7; refer to 2.3.2.1) and the requirements of International Union of Food Science and Technology (refer to 2.3.1.2), show extensive agreement (refer to Table 2.2).

2.3.3.4 Australian educational guidelines for food science and technology

The Australian Institute of Food Science and Technology (AIFST) is a non-profit organisation representing food industry professionals in Australia, including but not limited to food scientists and technologists. One of the aims of the organisation is to support building the skills and capacities of food professionals to meet the requirements of a global environment. Members of the organisation can make use of a ‘career mapping’ tool to plan their career path. The tool consists of four stages, namely the self-assessment stage, the development and investigative stage, the decisions and actions planning stage, and the implementation stage. Self-assessment allows the members to assess their skills and capabilities and to plan for further self-development. The organisation does not prescribe core competencies for food professionals but endorses the IFSCC ‘Certified Food Scientist®’ certification of the IFT (refer to 2.3.1.1 a). The career mapping tool was examined to identify any gaps that may exist in the content of the draft questionnaire.
2.3.3.5 Summarising food science and technology knowledge, skills and competencies

Table 2.2 provides a summary of the discipline-specific knowledge areas identified by the IFT (refer to 2.3.1.1), the IUFoST (refer to 2.3.1.2), the IFST (refer to 2.3.1.3), and the TRACK_FAST project (refer to 2.3.1. and Figure 2.7).

**Table 2.2: Summary of broad food science and technology-specific knowledge areas**

<table>
<thead>
<tr>
<th>FST discipline-specific knowledge, skills and competencies</th>
<th>IFTa</th>
<th>IUFoSTbX</th>
<th>IFSTc</th>
<th>UK QAAd</th>
<th>Trackfast _EUe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied food science (see 2.3.1.5 l)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Environmental impact</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Ethical challenges in food chains</td>
<td></td>
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<td>X</td>
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</tr>
<tr>
<td>Food analysis: chemical, physical, biological (see 2.3.1.5 a)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food biotechnology (see 2.3.1.5 f)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food business management</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food characteristics and physical properties (see 2.3.1.5 a)</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Food chemistry (see 2.3.1.5 c)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food commodities (see 2.3.1.5 h)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food composition (see 2.3.1.5 a &amp; c)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food control &amp; legislation (see 2.3.1.5 e)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food economics and marketing</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food engineering (see 2.3.1.5 i)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>FST discipline-specific knowledge, skills and competencies</td>
<td>IFT&lt;sup&gt;a&lt;/sup&gt;</td>
<td>IUFoST&lt;sup&gt;b*&lt;/sup&gt;</td>
<td>IFST&lt;sup&gt;c&lt;/sup&gt;</td>
<td>UK QAA&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Trackfast _EU&lt;sup&gt;e&lt;/sup&gt;</td>
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</tr>
<tr>
<td>Food marketing (see 2.3.1.5 j)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food microbiology (see 2.3.1.5 f)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food nutritional quality (see 2.3.1.5 d)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Food packaging (see 2.3.1.5 g &amp; k)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food preservation and associated unit operations (see 2.3.1.5 h)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food processing and associated unit operations (see 2.3.1.5 h)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>Food product development (see 2.3.1.5 j)</td>
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<td></td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Food production and operations management (see 2.3.1.5 h)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food quality assurance (see 2.3.1.5 k)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Food safety (see 2.3.1.5 k)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fundamental science</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Human nutrition (see 2.3.1.5 d)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sensory evaluation (see 2.3.1.5 b)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Primary food production (see 2.3.1.5 h)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Water &amp; waste management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

* Shaded areas denote commonality between organisations
** IUFoST includes areas covered in the textbook prescribed by the organisation

a. Institute of Food Technologists: United States of America
b. International Union of Food Science and Technology: Canada
c. Institute of Food Science and Technology: United Kingdom
d. Quality Assurance Agency for Higher Education: United Kingdom
e. Training Requirements and Careers for Knowledge-based Food Science and/or Technology in Europe Project

Based on this summary (refer to Table 2.2) and other literature reviewed, including the IUFoST reference book (Campbell-Platt, 2018:1-534), the section of the questionnaire that probed the food science and technology discipline-specific knowledge, skills and competencies required of South African food science and technology graduates was developed. It was divided into subsections, each representing a specific aspect of food science and technology discipline-specific knowledge, skills and competencies. These subsections are described next.

a) Food analysis

Table 2.2 highlights the requirement for knowledge, skills and competencies related to chemical, physical, biological food analysis and food characteristics and physical properties. The questionnaire divided food analysis into two subsections, namely analytical, and biochemical, chemical and microbial analysis since Johnston et al. (2014:16) report the need for more focus on microbial “detection methods actually used by the industry today”. The first subsection probed the analytical procedures used to provide information about the characteristics of food and beverage products, such as nutritional composition and physical properties. The second subsection probed microbial analysis knowledge, skills and competencies related to food safety and quality.

b) Sensory analysis

Sensory analysis (refer to Table 2.2) is synonymous with sensory evaluation and sensory science. Carpenter, Lyon and Hasdell (2000:xix) describe sensory analysis as using the five human senses to identify, measure, analyse and interpret the sensory attributes of a product. Sensory analysis in this context refers to consumer perception techniques including quantitative and qualitative consumer research and scientific, methodical and focused sensory analysis (Carpenter et al., 2000:1). More recently, sensory evaluation methods and techniques have been classified to include analytical
methods in addition to consumer perception methods (Heymann & Ebeler, 2017:35). Sidel and Stone (1993:65) suggest that sensory evaluation based on perceptions of both consumer and ‘expert’ sensory analysis is ‘critical’ to inform decisions for successful food product development and initiatives to improve quality, extend the shelf-life and optimise the costs of food products; it allows a better understanding of consumers’ attitudes and perceptions. Considering this, sensory analysis has developed as a technical speciality (Sidel & Stone, 1993:65), and an understanding of the fundamental principles and procedures, including descriptive, preference and discrimination tests and statistical data analysis techniques, are widely recognised as a requirement of food science and technology undergraduate curricula (refer to Table 2.2). Sensory science has been added to the revised ‘core competencies’ of the IFT (2019:7).

c) Food chemistry

Food chemistry is an integral branch of food science and technology that focuses on the desirable and undesirable chemical changes that occur in foods during primary production, food processing and storage (Mehta & Cheung, 2015:3). The composition and chemical, physical, and functional properties of raw ingredients, foods and food products and how these influence characteristics of the food such as the nutritional value, sensory properties, food safety, shelf-life, spoilage and processing properties, are considered (Mehta & Cheung, 2015:3). Food chemistry knowledge, skills and competencies is supported as an essential requirement of an undergraduate food science and technology programme (see Table 2.2) and was therefore included in the questionnaire.

d) Nutrition

The World Health Organisation (WHO, n.d.) defines nutrition simply as the “intake of food, considered in relation to the body’s dietary needs”. This implies that nutrition is the field of study that considers food in relation to human health and the control of noncommunicable diseases such as diabetes, obesity and hypertension. Beauman, Cannon, Elmadfa et al., (2015:695), observe that although there are many definitions
of nutrition, there is no commonly agreed definition. These authors propose the following definition:

*The study of food systems, foods and drinks, and their nutrients and other constituents; and of their interactions within and between all relevant biological, social and environmental systems.*

This definition supports that there is a strong link between nutrition science and food science and technology. Levin and Labuza (1990:234) observe that nutritional knowledge and changing understanding influences the way food is processed and the development of nutritionally-targeted food products, such as foods enriched with vitamins and minerals, lower fat and kilojoule-controlled foods, and lower sodium foods. The growth of nutraceutical foods, which include functional foods and nutritional supplements that deliver health benefits and/or treat or prevent diet-related diseases (Kalra, 2003:1) such as cardiovascular diseases (Alissa & Ferns, 2012:2), is of growing importance. These ‘designer’ foods, which have additional benefits over and above their nutritional value (Rajasekaran & Kalaivani, 2013:1), are commonly developed as a collaboration between food scientists and technologists and nutritionists; as such, a fundamental knowledge of nutritional science may be expected from food science and technology graduates. Furthermore, Table 2.2 identifies ‘food nutritional quality’ and ‘human nutrition’ as requirements for undergraduate food science and technology qualifications. A subsection probing of the importance of nutrition knowledge, skills and competencies was thus included in the questionnaire.

e) **Food regulation and control including legislation**

According to the FAO, consumers have the right to access enough safe and nutritious food. Therefore, governments have an obligation to ensure that this is achieved through a “food control infrastructure include food law and accompanying regulations, a food inspectorate, analytical services and compliance unit, and support services of education, information, training and advisory support” (FAO, 2000:7.3). As food science and technology is the study and application of food properties, including nutritional properties in relation to food processing and storage (IFST, 2015:2; IFT, 2011:4; Potter & Hotchkiss, 1998:1), it may be expected that food control and
regulation are required graduate outcomes of food scientists and technologists. The necessity for ‘food control and legislation’ knowledge, skills and competencies are reflected in Table 2.2 as a requirement of food science and technology undergraduate qualifications, and as such, was included in the questionnaire.

f) Food and general microbiology

The importance of microbiology in the processing and distribution of safe, quality food and beverage products is well recognised (Bejarano, 2017:00114; Gill, 2017:1). In addition, the use of micro-organisms to produce fermented food products, which have unique functional properties and a range of added health benefits (Tamang, Shin, Jung & Chae, 2016:1), has been widely practised since ancient times (Caplice & Fitzgerald, 1999:131). Food microbiology was identified as essential knowledge, skills and competencies for undergraduate food science and technology programmes (refer to Table 2.2) and questions were subsequently formulated for inclusion in the draft questionnaire based on the literature reviewed.

g) Food packaging

Packaging technology plays a central role in maintaining the safety and quality of foods after manufacture and during storage and distribution (Marsh & Bugusu, 2007:39). In addition to product requirements and marketing needs, food packaging must take other factors into account, including energy and material costs, legislation, sustainability issues, and environmental and waste management considerations (Marsh & Bugusu, 2007:51). For these reasons and because the choice of packaging material to balance these considerations is unique to the product (Marsh & Bugusu, 2007:39), it can be expected that food scientists and food technologists must have knowledge, skills and competencies in food packaging to evaluate and select suitable packaging. Food packaging knowledge, skills and competencies are reflected as a requirement in food science and technology undergraduate programmes (refer to Table 2.2), and questions were formulated based on the literature reviewed for inclusion in the questionnaire.
h) Food processing

Food processing refers to several diverse ‘unit operations’ used to convert raw materials into food products which can be consumed by people or converted to animal feeds (Earle & Earle, 1983:About the book). An example of food processing unit operations is the application of the principles of heat transfer to the heating and cooling processing unit operations, such as heat pasteurisation and sterilisation, and refrigeration and freezing. Earle and Earle (1983:Introduction) suggest that it is essential for food scientists and technologists to understand the basic principles, design and purpose of food processing equipment and how the equipment operates. This requirement is echoed in Table 2.2, which indicates that food processing, food preservation and food production knowledge, skills and competencies are fundamental to undergraduate food science and technology programmes. As such, the draft questionnaire contained a section probing essential food processing and preservation knowledge, skills and competencies.

i) Food engineering

Food engineering forms the scientific basis for food processing (Earle & Earle, 1983:About the book; refer to 2.3.4.5 h). Furthermore, it combines the principles of food processing with a mechanical engineering approach to chemical technology and is often referred to as “process engineering” (Kostaropoulos, 2012:110). As such, knowledge, skills and competencies of food engineering and food processing unit operations are inextricably bound. Table 2.2 indicates that food engineering is an essential area in undergraduate food science and technology programmes, and therefore a section probing the necessary food engineering knowledge, skills and competencies was included in the draft questionnaire.

j) Food product development

Product development is a ‘fluid and loosely structured’ process comprising several steps or stages where the activities and methods used can be varied to meet the unique needs of the new product being developed (Earle & Earle, 2009:Preface). Fuller (2016:1) observes that the need for food product development should be evident
to even the most inexperienced food scientist or technologist, as it is required to encourage the economic growth of a company and maintain competitiveness and profitability. Ho et al. (2011:2) classify product development as “specific general” food research and development skill, and they identify it as an essential skill of food scientists and technologists within the EU. The research and development skills associated with food product development include the application of the knowledge of food ingredients, food safety and quality, sensory analysis, food processing, food legislation, food packaging, and food marketing, to name a few. Table 2.2 indicates that food product development is an area which should be included in undergraduate food science and technology programmes, and it was included in the questionnaire.

k) Food safety and quality management

The FAO states that food quality and safety assurance is required to provide protection for consumers, and to enable international trade. The FAO proposes that this can be achieved by implementing an appropriate food quality assurance system (Whitehead, n.d.:para. 1). This responsibility rests with the Codex Alimentarius Commission (CAC) who has the responsibility of implementing the Joint Food and Agricultural Organisation and World Health Organisation (FAO/WHO) Food Standards Program which entails establishing international food quality and safety standards based on scientific analysis and evidence. Consequently, food safety adopts a risk-based approach including risk identification, risk assessment and risk analysis, and focusses on preventing food contamination by biological, chemical and physical hazards, and the reduction/elimination or control of hazards associated with food products to ensure that the food is safe for human and animal consumption (CAC, 2009:6, 51). Food science and technology is acknowledged to play a pivotal role in food safety and food risk mitigation (Raley, Ragona, Sijtsem, Fische & Frewer, 2016:40), and is considered by some experts to be the most important function of food scientists and technologists (Flores et al., 2010:572; McElhatton & Marshall, 2007:ix). Food safety can be viewed as an element of overall food quality in that safe food requires the delivery of consistent quality (Petrović, Miličević, Nastasijević, Đorđević, Trbović & Velebit, 2017:1). Therefore, this study linked food safety and food quality scientific and technical knowledge, skills and competencies into one subsection in the questionnaire developed for this study. However, the recent IFT’s ‘core competencies’ differentiate
between food safety and food quality assurance (IFT, 2019:6-8; refer to Figure 2.9). The findings reported in Table 2.2 also show that the scientific and technical area of food safety and food quality assurance is a required component of undergraduate food science and technology programmes, and the literature reviewed was used to formulate questions to measure the perceived importance of food safety and quality management.

I) Applied food science and technology

The IFT identifies applied food science as one of the four broad core competencies required from food science and technology graduates (IFT, 2011:7; refer to Figure 2.8). However, the revised educational guidelines (IFT, 2019:6-8) require the learning outcomes of all the listed core competency areas to reflect the application of knowledge, and it is no longer identified as a separate core competency. Table 2.2 shows that there is consensus with respect to the need for food science and technology graduates being able to apply food science and technology knowledge, skills and competencies in the real world. This is supported by other authors who suggest that not only is the relevant discipline-specific knowledge, skills and career competencies needed (Akkermans et al., 2013:258; Dench et al., 2000:40; Griesel & Parker, 2009:16; Pool & Sewell, 2007:280), but graduates must have the skills that allow them to effectively apply the disciplinary-specific knowledge (Bennett et al., 1999:71; Griesel & Parker, 2009:13; Saunders & Zuzel, 2010:Table 5). Therefore, the questionnaire had a section probing the importance of applied food science and technology.

2.3.4 Summarising graduate capabilities

Graduate capabilities are proposed as the abilities and qualities (Oliver, 2011:7) that allow graduates to assume their unique identities to ‘become’ (Barnett, 2004:248). Graduate capabilities are proposed to be best developed in the context of the discipline and in terms of this study incorporate interrelated aspects (refer to Figure 2.2).
There are countless and elaborated lists of skills, attributes and competencies associated with generic graduate attributes and the related concepts of employability and graduateness, including personal attributes, desired to develop a holistic graduate. What is not always evident is how the lists were synthesised, and if there is a common understanding of what is meant by the skills, attributes and competencies that appear on the lists (Barrie, 2004:262). This means that finding commonalities between the lists is difficult, and categorising attributes into those needed to demonstrate employability versus those required to demonstrate graduateness is even more challenging (Yorke & Knight, 2006:7). This is also true of those attributes associated with personal characteristics, dispositions and attitudes. Table 2.3 provides an analysis of the generic graduate attributes and associated employability skills, characteristics of graduateness and personality attributes identified that formed the framework for the content of the data collection questionnaire developed for this study.

To identify the graduate capabilities required from South African food scientists and technologists, the content of the questionnaire was grouped according to the following aspects (Dench et al., 2000:11; Ho et al., 2011:9-11; Saunders & Zuvel, 2010: Phase 1: Employability skills questionnaires):

a) ‘non-discipline’ **generic graduate attributes**, including those associated with **employability** and **graduateness** (refer to Table 2.3);

b) **personal attributes**, including qualities and attitudes to successfully engage with the world (refer to Table 2.3); and

c) **food science and technology-specific knowledge, skills and competencies** to ‘do the job’ (refer to Table 2.2 & 2.3.4.5 a-i).

### 2.3.4.1 Generic graduate attributes

This section of the questionnaire, rather than being called ‘generic graduate attributes’ was called ‘employability/employment skills’ to make it more understandable to the participants. The items included in the draft questionnaire were identified through several literature sources as important to the employability of graduates in general (refer to Table 2.3), and required of food science and technology graduates in
particular (refer to 2.3.4). The section contained further subsections namely general employability skills, general written and verbal communication skills, leadership and management skills, and diversity management skills.

a) General employability or employment skills

This subsection probed the core skills such as effective reading, numeracy and mathematical skills, computer literacy, and fundamental organisation skills as identified in Table 2.3.

b) Written and verbal communication skills

Written and verbal communication was captured as two separated subsections as the ability to properly communicate is considered an essential generic transferable skill (Adam, 2009:174; Adayemo et al., 2010:104; Allais, 2017:156). Hitchliffe and Jolly (2011:570) observe that some employers value communication skills, such as the ability to present ideas verbally and in writing, as more important than technical skills. The importance of communication as a required graduate attribute is further illustrated when one considers that within the South African context, “producing and communicating of information” is one of the ten categories listed to describe “applied competencies” in the level descriptors provided for in the South African National Qualifications Framework (NQF) (SAQA, 2012:3). This specific category requires a student at undergraduate level to be able to “present and communicate complex information reliably and coherently” (SAQA, 2012:9), and to “develop and communicate own ideas and opinions in well-formed arguments” (SAQA, 2012:10).

c) Leadership and management skills

This subsection probed the importance of process skills such as prioritising and planning (Yorke & Knight, 2006:8). Jack, Anderson and Connolly (2012:14) describe “general business management skills” as those skills that are becoming increasingly important to the employability of graduates.
### Table 2.3: Summary of generic graduate attributes, skills and competencies identified through literature

<table>
<thead>
<tr>
<th>Attributes, skills and competencies</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical thinking</td>
<td>Coetzee, 2014:888</td>
</tr>
<tr>
<td>Attention to detail</td>
<td>Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92</td>
</tr>
<tr>
<td>Citizenship – moral and global</td>
<td>Barrie, 2004:270; Coetzee, 2014:889</td>
</tr>
<tr>
<td>Complexity – coping with</td>
<td>Yorke &amp; Knight, 2006:8, #32</td>
</tr>
<tr>
<td>Conflict resolution</td>
<td>LeGrand et al., 2017:118</td>
</tr>
<tr>
<td>Critical thinking</td>
<td>Artess et al., 2017:17; Coetzee, 2014:889; Coetzee, 2014:889; IFT, 2011:8; Purpura, 2008:3; Siegel, 2010:141; Yorke &amp; Knight, 2006:8, # 16</td>
</tr>
<tr>
<td>Decision-making, decisiveness</td>
<td>Coetzee, 2014:888; Jackson, 2009:93; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8, #37</td>
</tr>
<tr>
<td>Entrepreneurship, enterprising skills</td>
<td>Artess et al., 2017:17; Coetzee, 2014:889; Maxwell &amp; Armellini, 2019:76; Sewell &amp; Pool, 2010:11 &amp; 92</td>
</tr>
<tr>
<td>English proficiency</td>
<td>Griesel &amp; Parker, 2009:13</td>
</tr>
<tr>
<td>Ethical behaviour/conduct</td>
<td>Barrie, 2004:270; Coetzee, 2014:889; IFT 2011:8; Oliver, 2011:2; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, #30</td>
</tr>
<tr>
<td>Evaluate work performance, plan improvement</td>
<td>Griesel &amp; Parker, 2009:17 &amp; 18</td>
</tr>
<tr>
<td>Financial skills</td>
<td>LeGrand et al., 2013:118</td>
</tr>
<tr>
<td>Global awareness – general knowledge, cultural differences, economic understanding</td>
<td>Griesel &amp; Parker, 2009:16; Yorke &amp; Knight, 2006:8, #22</td>
</tr>
<tr>
<td>Goal-directed behaviour</td>
<td>Coetzee, 2014:889</td>
</tr>
<tr>
<td>Graduateness / metacognition – not specified</td>
<td>Coetzee, 2014:889</td>
</tr>
<tr>
<td>Attributes, skills and competencies</td>
<td>Source</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Information retrieval and use</td>
<td>Coetzee, 2014:889; Griesel &amp; Parker, 2009:13; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Information technology, computer literacy and management of information</td>
<td>Barrie, 2004:270; Bennett et al., 2000:32; Coetzee, 2014:889; Dearing 1997:202; Dench et al., 2000:38; Griesel &amp; Parker, 2009:13; Oliver, 2011:2; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, # 13 &amp; 23</td>
</tr>
<tr>
<td>Initiative, idea generation and innovation</td>
<td>Coetzee, 2014:889; Griesel &amp; Parker, 2009:16 &amp; 19; Oliver, 2011:2; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>Andrews &amp; Higson, 2008:411; Barrie, 2004:270; Coetzee, 2014:889; Griesel &amp; Parker, 2009:19; IFT, 2011:8; Oliver, 2011:2; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, #36</td>
</tr>
<tr>
<td>Leadership skills</td>
<td>Griesel &amp; Parker, 2009:19; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92</td>
</tr>
<tr>
<td>Listening and questioning skills</td>
<td>Griesel &amp; Parker, 2009:16; IFT, 2011:7; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, #8</td>
</tr>
<tr>
<td>Malleable</td>
<td>Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Management of tasks / project management / planning / organisational skills</td>
<td>Bennett et al., 2000:32; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8, #28 &amp; 29</td>
</tr>
<tr>
<td>Metacognition</td>
<td>Knight &amp; Yorke, 2002:266; National Research Council, 2012:6-20; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Multi-tasking</td>
<td>Artess et al., 2017:17; Dench et al., 2000:34 &amp; 42; IFT, 2011:8</td>
</tr>
<tr>
<td>Negotiating skills</td>
<td>Griesel &amp; Parker, 2009:19; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, #38</td>
</tr>
<tr>
<td>Networking</td>
<td>Griesel &amp; Parker, 2009:19; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Organisational skills</td>
<td>Archer &amp; Davidson, 2009:10; Chipchase et al., 2012:7</td>
</tr>
<tr>
<td>Personal and professional development</td>
<td>Coetzee, 2014:889; Dench et al., 2000:40; Griesel &amp; Parker, 2009:16; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Political sensitivity</td>
<td>Yorke &amp; Knight, 2006:8, #24</td>
</tr>
<tr>
<td>Problem-solving</td>
<td>Coetzee, 2014:888; Dench et al., 2000:39; Griesel &amp; Parker, 2009:16; Flynn et al., 2013:249; IFT, 2011:8; Oliver, 2011:2; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8, #33</td>
</tr>
<tr>
<td>Professional understanding</td>
<td>Barrie, 2004:270; Griesel &amp; Parker, 2009:16</td>
</tr>
<tr>
<td>Reflectiveness</td>
<td>Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Attributes, skills and competencies</td>
<td>Source</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Research and enquiry – construct and apply knowledge</td>
<td>Barrie, 2004:270; Griesel &amp; Parker, 2009:16; IFT, 2011:8</td>
</tr>
<tr>
<td>Responsibility</td>
<td>Bloom &amp; Kitagawa, 1999:3; Coetzee, 2014:889; Dench et al., 2000:39</td>
</tr>
<tr>
<td>Scholarship - general</td>
<td>Barrie, 2004:270; Coetzee, 2014:888</td>
</tr>
<tr>
<td>Team working</td>
<td>Bloom &amp; Kitagawa, 1999:3; Dench et al., 2000:39; Griesel &amp; Parker, 2009:19; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92</td>
</tr>
<tr>
<td>Thinking skills – analytical, critical, creative and</td>
<td>Bloom &amp; Kitagawa, 1999:3; Coetzee, 2014:888; Griesel &amp; Parker, 2009:13 &amp; 16; IFT, 2011:8; Oliver, 2011:2; Pegg et al., 2012:6; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8, #16, 17</td>
</tr>
<tr>
<td>Team working</td>
<td>Bloom &amp; Kitagawa, 1999:3; Dench et al., 2000:39; Griesel &amp; Parker, 2009:19; IFT, 2011:8; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92</td>
</tr>
<tr>
<td>Time management</td>
<td>IFT, 2011:8; Sewell &amp; Pool, 2010:92</td>
</tr>
<tr>
<td>Commitment</td>
<td>Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Collaboration skills, cooperation</td>
<td>Oliver, 2011:2; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Creativity</td>
<td>Artess et al., 2017:17; Coetzee, 2014:889; Griesel &amp; Parker, 2009:19; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:91</td>
</tr>
<tr>
<td>Dependability</td>
<td>Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Emotional intelligence/social intelligence</td>
<td>Artess et al., 2017:17; Pool &amp; Sewell, 2007:280-1; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Enthusiasm, high energy</td>
<td>Coetzee, 2014:889; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Initiative, proactive</td>
<td>Artess et al., 2017:17; Coetzee, 2014:889; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Integrity/ethics</td>
<td>Artess et al., 2017:17; Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Perseverance, resilience</td>
<td>Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Positive attitudes and behaviours</td>
<td>Artess et al., 2017:17; Bloom &amp; Kitagawa, 1999:3; Flynn et al., 2013:249</td>
</tr>
<tr>
<td>Resilience</td>
<td>Artess et al., 2017:17</td>
</tr>
<tr>
<td>Self-awareness, self-identity</td>
<td>Griesel &amp; Parker, 2009:19; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Self-confidence, self-esteem,</td>
<td>Griesel &amp; Parker, 2009:19; Pegg et al., 2012:4; Pool &amp; Sewell, 2007:280-1; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Self-management</td>
<td>Akkermans &amp; Tims, 2016:1; Artess et al., 2017:17; Bennett et al., 2000:32; Bridgstock, 2009:32; Saunders &amp; Zuzel, 2010: Table 5; Yorke &amp; Knight, 2006:8, #15</td>
</tr>
<tr>
<td>Self-motivation</td>
<td>Coetzee, 2014:889; Griesel &amp; Parker, 2009:19; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Sensitivity, respect, empathy</td>
<td>Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Stress tolerance</td>
<td>Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:92; Yorke &amp; Knight, 2006:8</td>
</tr>
<tr>
<td>Timekeeping, punctuality</td>
<td>Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Work ethic, willingness to learn</td>
<td>Artess et al., 2017:17; Dench et al., 2000:37; Griesel &amp; Parker, 2009:20; Saunders &amp; Zuzel, 2010: Table 5; Sewell &amp; Pool, 2010:91</td>
</tr>
</tbody>
</table>

**Personal attributes, qualities and attitudes**

- Adaptability, flexibility
- Commitment
- Collaboration skills, cooperation
- Creativity
- Dependability
- Emotional intelligence/social intelligence
- Enthusiasm, high energy
- Initiative, proactive
- Integrity/ethics
- Perseverance, resilience
- Positive attitudes and behaviours
- Resilience
- Self-awareness, self-identity
- Self-confidence, self-esteem
- Self-management
- Self-motivation
- Sensitivity, respect, empathy
- Stress tolerance
- Timekeeping, punctuality
- Work ethic, willingness to learn
In summarising the skills enhanced through work-integrated learning, Jackson (2015:356) identifies that many leadership and management skills such as teamwork, self-awareness, critical thinking, problem-solving, developing initiative and enterprise, self-management, social responsibility and professionalism are promoted through work-integrated learning. However, not all food science and technology academic programmes support work placement opportunities and based on the assumption that certain leadership and management skills may be considered important when a graduate first takes up employment, questions probing the required skills were included in the questionnaire (see Table 2.3).

Entrepreneurship skills were identified through Table 2.3 to be a valuable generic graduate attribute (Maxwell & Armellini, 2019:76) that may be expected from food science and technology graduates. In addition, the lack of entrepreneurial skills within South Africa has resulted in pressure on higher education institutions to develop the entrepreneurial skills of its graduates (SA DHET, 2013:122). For this reason, a question probing the perceived importance of developing the entrepreneurial skills of food science and technology students was included in the subsection examining leadership and management skills.

**d) Diversity management skills**

Diversity management skills was identified as one of the generic graduate attributes (refer to Table 2.3). Workplace diversity is associated with several benefits, such as improved problem-solving and decision-making, but it is also associated with challenges such as workplace discrimination (Singh et al., 2013:243). Successful diversity management allows for a positive work environment where all employees are considered equal, unique and valuable in meeting the goals of the organisation (Patrick & Kumar, 2012:2; Singh et al., 2013:243). The management of a diverse labour force and the growing importance of managing diversity within the workplace is evident worldwide (Singh et al., 2013:243). As a result, many organisations are actively managing workplace diversity and promoting diversity management skills through training initiatives (Patrick & Kumar, 2012:2; Singh et al., 2013:244; Wambui et al., 2013:200). Also, the importance of effectively managing a diverse workforce to harness the potential of employees for competitive advantage (Patrick & Kumar,
2012:18), especially in demographically diverse workplaces such as those in South Africa, cannot be overstated (de Beer, 2011:14; Singh et al., 2013:244; Wambui et al., 2013:203). In this regard, Jackson (2009:85) proposes that graduates are expected to demonstrate effective diversity management.

There are growing calls for higher education institutions to integrate diversity management skills into undergraduate curricula; not only as an employability skill but for global mobility (Kulik & Roberson, 2008:309). Based on the hypothesis that diversity management skills may be expected from food science and food technology graduates when they first enter the workplace, the next subsection of the questionnaire captured possible diversity management skills identified as important through literature (refer to Table 2.3).

2.3.4.2 Personal attributes

Personal attributes are associated with the translation of disciplinary knowledge and “application in the real world”, implying that the enhancement of personal attributes is a necessary outcome of higher education (Barnett, 2009:434). Hughes and Barrie (2010:328) warn against viewing personal attributes required of graduates as being only generic as they may also to be discipline-specific. This sentiment is supported by Barnett (2009:434), who proposes that personal attributes are specific to the field of study and the occupation, vocation or profession. For this reason, a section aimed at identifying the particular mix of personal attributes required to be an effective food scientist and technologist was included in the questionnaire (refer to Table 2.3).

2.3.4.3 Food science and technology knowledge, skills and competencies

The aim of the data collection instrument was to identify the graduate capabilities that food science and technology students must demonstrate when they graduate. Therefore, based on the analysed literature, the questionnaire had a section probing the expected and required food science and technology knowledge skills and competencies. The following fundamental food science and technology knowledge, skills and competencies were included in the questionnaire based on the literature reviewed (see Table 2.2) and the outcome of the focus group discussion: food
analysis; sensory analysis; food chemistry; nutrition; food control, regulation and legislation; food microbiology; food safety; food quality assurance; and applied food science and technology.

Table 2.4 outlines the basis on which the food science and technology discipline-specific questions were formulated for this section of the questionnaire.

### Table 2.4: Disciplinary-specific knowledge, skills and competencies

<table>
<thead>
<tr>
<th>Discipline knowledge</th>
<th>Knowledge, skills and competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breadth of knowledge &amp; understanding concepts</td>
<td>Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
<tr>
<td>Relevant discipline-specific knowledge, skills and career competencies</td>
<td>Akkermans et al., 2013:258; Andrews &amp; Higson, 2008:411; Bennet et al., 1999 Dench et al., 2000:40; Griesel &amp; Parker, 2009:16; Pool &amp; Sewell, 2007:280-1</td>
</tr>
<tr>
<td>Skills that allow the effective application of disciplinary-specific knowledge</td>
<td>Bennett et al., 1999:71; Griesel &amp; Parker, 2009:13; Pool &amp; Sewell, 2007:280-1; Saunders &amp; Zuzel, 2010: Table 5.</td>
</tr>
<tr>
<td>Breadth of knowledge &amp; understanding concepts</td>
<td>Saunders &amp; Zuzel, 2010: Table 5</td>
</tr>
</tbody>
</table>

### 2.4 ENHANCING GRADUATE ATTRIBUTES AND CAPABILITIES

The nature of graduate attributes and capabilities can be defined in terms of the outcomes of higher education (Barnett & Coate, 2005:102; Barrie, 2004:262), although employability skills are often suggested to be better developed in the workplace (Bowers-Brown & Harvey, 2004:213; Yorke, 2006:11). Realistically, higher education can only facilitate the development of the required characteristics to assist the graduate to be successful in employment (Brunner, McGregor, Keep, Janssen, Spallek, Quinn, Jones, Tseris, Yeung, Togher, Solman & Shaw, 2018: Abstract; Yorke, 2006:11) and to display citizenship and scholarship (Barnett, 2009:430).

Higher education can achieve the required graduate capabilities through initiatives such as programme design; integrating the generic graduate attributes and discipline-specific requirements into the curriculum (Venkatraman, Wah, de Souza-Daw & Kaspi, 2017:102); introducing relevant and innovative teaching and learning practices, including the use of technology (Yorke, 2006:14); and through collaborations with stakeholders such as workplace or work-integrated learning (Bond et al., 2017:43; Jackson, 2015:350; Rateau, 2011:110; Saunders & Zuvel, 2010:
Introduction, para. 4). Such initiatives are often left to the interpretation of, and implementation by, individual academics involved with teaching specific modules or units within the curriculum (Barrie, 2004:261). Consequently, attempts to describe and methods to develop graduate capabilities holistically may vary in approach and are often not supported by theoretical and conceptual principles (Barrie, 2004:263).

However, embedding and enhancing generic graduate attributes and the associate employability skills, characteristics of graduateness and personal attributes, has received a diverse variety of often inconsistent approaches (Barrie, 2004:265; Bennet, Richardson & MacKinnon, 2016:33). Some countries, such as the UK, address generic graduate attributes at a national level and emphasise employability (CBI, 2010:5; Yorke, 2010:1). Other countries, such as Australia, require generic graduate attributes to be addressed at the level of higher education institutions (Barrie, 2009:152; Barrie et al., 2009:1; Cleary et al., 2007:22 & 26; Knight & Yorke, 2002:261; Australian Workforce and Productivity Agency, 2013:8). Cleary et al. (2007:12) report that Australian higher education institutions are required to have generic graduate attribute policies in place to obtain government funding. These policies may prescribe if graduate attributes are addressed at the institutional level, qualification level or at the individual module or unit level. This approach requires that graduate attributes, often an elaborate and detailed list, are embedded into the curriculum of the qualification and are at a level that aligns to the level and type of qualification (Bennett et al., 2016:33; Cleary et al., 2007:13; Kalfa & Taksa, 2015:584). Within the EU, the Bologna Declaration (European Ministers of Education, 1999) promoted the notion of graduate attributes and capabilities at regional level (Barrie, 2007:439; Campbell & Rozsnyai, 2002:9). Other models and frameworks have been proposed that may assist higher education institutions to identify approaches to develop and enhance the generic graduate attributes, including employability skills and graduateness (Bond et al., 2017:43; Brunner et al., 2018:Abstract; Coetzee, 2012a:119; Cole & Tibby, 2013:10; Jääskelä, Nykänen & Tynjälä, 2018:130; Maxwell & Armellini, 2019:76). There are also mechanisms (Kember, Hong, Yau & Ho, 2017:799) and best practice guidelines to promote the development of graduate attributes (Kinash, Crane & Judd, 2016:6).
Instead of a non-specific approach to developing generic graduate attributes, more recently graduate attributes are being proposed to be better developed by adopting a contextual and discipline-specific approach which may be unique to each student (Barrie, 2006:271; Barnett & Coate, 2005:102; Cleary et al., 2007:13; Kalfa & Taksa, 2015:584; Yorke, 2006:8). Thus, far from being generic, graduate attributes are contextual and may vary between disciplines (Barrie, 2004:272). In fact, even if there are generic graduate attribute statements available from specific higher education institutions, as in the case of the University of Stellenbosch, these would still have to be contextualised and made relevant to the discipline and meet the requirements of the relevant stakeholders (Barrie, 2004:273).

Instead of focusing only on the required generic graduate attributes, this study interrogated the ‘combined’ graduate attributes (Griesel & Parker, 2009:7), synonymous with the term ‘graduate capabilities’, to represent the essential characteristics of graduates within the South African context. Griesel and Parker (2009:7) describe the ‘combined graduate attributes’ as broader than generic skills and include the prerequisite discipline-specific knowledge, skills and competencies that will allow graduates to find and take up employment within a chosen profession. The efforts of higher education in South Africa should be in developing students who will demonstrate an array of graduate characteristics that reflect efforts to address the requirements of employability and graduateness in the context of the discipline and the necessary discipline-specific knowledge, skills and competencies to meet the expectations of societal stakeholders (Holmes, 2013:1047; Kalfa & Taksa, 2015:584).

To this end, this study proposes educational strategies that will assist the academic staff teaching food science and technology students to develop students who demonstrate the required graduate capabilities to meet the expectations of societal stakeholders.

2.4.1 Assurance of delivery for graduate employability model

To assure the development of graduate outcomes, the Australian Government initiated several projects and fellowships through the Australian Learning and Teaching Council Inc. (Oliver, 2011:2). Graduate outcomes, in the context of this initiative, included discipline-specific outcomes and generic outcomes. Generic outcomes are referred to
as ‘graduate attributes’ which correspond with the conceptualisation of generic graduate attributes in this study. Oliver (2011:2) mentions that discipline-specific and generic graduate attributes are inseparable; however, this initiative focused separately on developing the outcomes related to discipline-specific outcomes and generic graduate attribute outcomes. Determining the discipline-specific learning outcomes started in 2010 through several projects and fellowships aimed at identifying standards for specific disciplines that participated in the project. Academic standards are available for nutrition, dietetics and general science qualifications, but not for food science and technology. Notably, the UK QAA for Higher Education ‘benchmark statements’ for food (QAA, 2016:7; refer to 2.5.2.3) was utilised as a resource when formulating the general science academic learning statements (ALTC, 2011b:32). There is also a general resource guide provided as a guideline for disciplines that did not take part in the project to assist them in developing discipline-specific learning outcomes (ALTC, 2011a).

To ‘assure’ graduate outcomes, Oliver (2011:2) advocates a quality assurance approach. A quality assurance approach is an evidence-based approach that, in the context of the Australian Learning and Teaching Council initiative to assure graduate outcomes, include (Oliver, 2011:2):

- Initiation - Determining the required graduate outcomes and the standard to which they are required.
- Deployment - Planning how to develop and assess the required outcomes.
- Review - Using stakeholder feedback to assess the standards at which the outcomes are achieved.
- Improvement - Based on the evidence of achievement, implementing improvement strategies to improve the graduate outcomes achieved.

Figure 2.10, an adapted version of the model proposed by Oliver (2010:12), provides an outline of how the aims of this study – that is, initially identifying the required graduate capabilities and deployment to facilitate the development of the capabilities by higher education – form part of a proposed strategy to enhance the graduate capabilities of food scientists and technologists. The mechanisms for reviewing the
The extent and level to which the required graduate capabilities are achieved will form the basis for future research. The educational strategies and approaches that will assist academic staff teaching food science and technology students to facilitate the development of graduate capabilities of food science and technology are described in a subsequent chapter.

![Diagram showing the continuous cycle of identifying, enhancing, deploying, reviewing, and improving graduate capabilities.]

**Figure 2.10: Framework for enhancing the graduate capabilities of food scientists and technologists (Adapted from Oliver, 2010:12)**

### 2.5 SYNTHESIS OF CHAPTER TWO

This chapter identified the concepts and themes relevant to this study. Following this, the identified concepts and themes were defined, classified and relationships were identified. The contemporary roles of higher education in postmodern society was illustrated, especially the aspect of meeting the needs of societal stakeholders and the community. Enhancing graduate capabilities and associated concepts was proposed as a method to develop holistic graduates who are effective in their discipline, profession or vocation. The aspects of graduate capabilities were unpacked and formed the concept of the draft questionnaire developed for this study. The research design and methodology are described in Chapter Three.
CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Simple it’s not, I’m afraid you will find, for a mind-maker-upper to make up his mind (Dr Seuss, 1990).

3.1 INTRODUCTION

Chapter One gave an introduction and overview of this study and described the research problem and rationale for conducting the study. Chapter Two gave a theoretical framework to support the empirical investigation of this study. Chapter Three examines the research design and methodology adopted for this study and motivates the choices made to answer the first research sub-question (refer to 1.4.2), namely:

**Sub-question 1:**
What graduate capabilities are required of newly graduated food scientists and technologists that will meet the requirements and expectations of South African societal stakeholders?

An overview of the structure of Chapter Three and the themes that will be addressed are provided in Figure 3.1.

![Figure 3.1: Overview of the structure: Chapter Three](image-url)
The empirical investigation followed a deductive, non-experimental quantitative approach and collected data by implementing a survey. This was a cross-sectional study, conducted in a real-world setting (Ary et al., 2014:447; Cohen, Manion & Morrison, 2000:138; Field, 2009:32; Saunders, Lewis & Thornton, 2009:138).

3.1.1 Background to the chapter

The rationale for undertaking this study was based on two considerations (refer to 1.4.1). The first was the discontent expressed by South African employers with the readiness of graduates in general to meet the needs of employment when they first enter the workplace (Chetty, 2012:5; Archer & Chetty, 2013:135; SA DHET, 2011:3). The second consideration was the limited literature supported by research that related to the higher education outcomes of food scientists and technologists in general, and more specifically, the required graduate capabilities of food scientists and technologists within the South African context (refer to 2.3.1).

The foremost aim of the study was to describe educational strategies to facilitate the academic staff teaching food science and technology students so that they can support students to ‘become’ food scientists and technologists who meet the expectations of the South African societal stakeholders when they graduate (Barnett, 2006:61). To achieve the overarching aim, the food science and technology graduate capabilities required within the South African context were initially researched by engaging with the opinions of interested and affected parties identified as important to this study. This was achieved by implementing a questionnaire specifically developed for this study and administered as a web-based survey.

Once the graduate capabilities were established, they were used as a baseline to determine the applicability of the 'Core Competencies for Food Science' (IFT, 2011:7 & 2019:6-8), and other available educational guidelines and learning outcomes for food science and technology educational programmes (refer to 2.3.4) within the South African context to answer the second research sub-question, namely:
3.2 RESEARCH APPROACH AND DESIGN

3.2.1 Introduction

Research is a systematic process that relies on the reasoning adopted by the researcher to better understand the world and discover new knowledge (Cohen et al., 2000:5). Positivism was identified as a suitable paradigm for this study (Aliyu et al., 2014:79; Ary et al., 2014:251; Creswell, 2012:19). The first phase of this study made use of a self-developed questionnaire, administered as a web-based survey, to collect data to answer the first two research sub-questions. This section motivates the choices made in this regard and describes the process of developing and deploying the questionnaire.

3.2.2 Research approach

A research approach outlines how the aims of the empirical inquiry will be achieved. This study was conducted contextually and was descriptive and exploratory in nature to achieve the stated aims (Ritchie, Lewis & Elam, 2003:74). The first aim of this study was to identify the required food science and technology graduate capabilities, including the generic graduate attributes and the discipline-specific knowledge, skills, competencies and attributes, as perceived by relevant interested parties. To achieve this aim, a quantitative approach was followed which involved implementing a questionnaire to collect data to identify the graduate capabilities required of newly graduated food science and technology students when entering the workplace for the first time. Deductive reasoning was followed to
3.2.3 Research strategy and design

The research strategy followed in this study allowed for a planned course of action to systematically collect data to answer the first and second research sub-questions (Ary et al., 2014:105; Babbie & Mouton, 2011:73; Brennan, 2005:12). Authors like Bergh and Theron (2003:21) describe the research strategy as a “specific, purposeful, and coherent strategic plan to execute a particular research project to render the research findings relevant and valid”. A research strategy can follow either inductive reasoning or deductive reasoning, or often a combination of both (Aliyu et al., 2015; Bernard, 2006:493; Cohen et al., 2000:5; Creswell, 2012:128). Figure 3.2 provides an overview of the research strategy followed in this study, by presenting linkages with the aims and objectives.

**Figure 3.2: The research strategy followed in this study**

An analysis of Figure 3.2 shows that this study consisted of an empirical and a deductive phase. The empirical phase answered the first two research sub-questions.
of this study. Firstly, literature was identified and used deductively to articulate the research questions of this study (Creswell, 2014:36). Then, deductive reasoning allowed for a structured and logical approach to decide on the content of the draft questionnaire developed for this study (Ary et al., 2014:4; Gray, 2013:22; Ormston, Spencer, Barnard & Snape, 2014:6). The finalised questionnaire was used to collect the data to identify the food science and technology graduate capabilities perceived as highly important by South African societal stakeholders. The data collected in the empirical phase was mainly quantitative in nature but also included text responses to open-ended questions and comment boxes. After analysing the data, the findings were interpreted and discussed making use of what is already known from previous studies and the literature reviewed to draw valid conclusions (Gray, 2013:31).

Subsequently, the deductive phase of this study formulated a facilitation process aimed at the academic staff teaching food science and technology students. This phase was informed by the findings of the empirical phase. A conceptual framework was developed that guided a facilitation process to develop the positive attitude and the necessary educational knowledge, skills and competencies of the academic staff to address challenges formulated through the findings. The facilitated academic staff will be able to help students to develop and enhance the required graduate capabilities during undergraduate studies to ‘become’ an effective food scientist or food technologist (Barnett, 2006:61). Identifying possible strategies to develop and enhance the required graduate attributes and capabilities was founded on inductive-deductive reasoning based on existing theories and knowledge (Bernard, 2006:493; Cohen et al., 2000:4; Creswell, 2014:207; Gray, 2013:16; Ormston et al., 2014:6).

A more detailed overview of the research design related to the research questions, including sampling and data collection methods adopted for the study, is presented in Table 3.1.
Table 3.1: Summary of the research design in relationship to the research questions

<table>
<thead>
<tr>
<th>Research sub-question/s to be answered</th>
<th>Target population / sampling</th>
<th>Data collection instrument/s and analysis</th>
</tr>
</thead>
</table>
| 1. What graduate capabilities are required of newly graduated food scientists and technologists that will meet the requirements and expectations of South African societal stakeholders? | • Purposively selected participants  
• Members (excluding student members) of the SAAFoST – includes food scientists and technologists, employers and colleagues of food scientists and technologists, food manufacturers, government, and academia  
• Snowball sampling (Ary et al., 2014:458) to identify additional stakeholders who are not members of SAAFoST but who may be influenced by the outcome of the study | Empirical investigation - web-based survey:  
• Literature review, drafting of questionnaire content areas and questions  
• Focus group discussion: Confirm questionnaire content and structure, identify omissions and additional questions  
• Finalise the questionnaire, convert to a web-based survey and pre-test/pilot  
• Survey structured into seven sections  
• Data collected using Likert-type rating scale questions (quantitative data) and open-ended questions/comments  
• Analysis of data as ordinal data |
| 2. To what extent are the international food science and technology educational requirements and guidelines identified through literature applicable in the South African context? | • As above                                                                                   | As above                                                                                                 |
| 3. How can the academic staff be facilitated to have the necessary attitudes, knowledge, skills and capabilities to optimally enable undergraduate food science and technology graduates to demonstrate the required graduate capabilities? | • Academic staff teaching food science and technology students                                  | Deductive investigation.  
• Develop a conceptual framework to guide the facilitation of the academic staff to address the challenges formulated from the findings of the situation analysis  
• Formulate strategies that can be used by academic staff to enable food science and technology students to demonstrate the perceived needed graduate capabilities. |
3.2.4 Research methodology

The research methodology selected for a research study considers how best to generate the data required to achieve the aims of the study which, in turn, informs the choice of the methods used (Buchanan & Hvizdak, 2009:37; Scotland, 2012:9). The choice of the research methods, apart from being directed by the research questions, is an ethical and pragmatic choice and is based on the fundamental views of the researcher and the paradigm adopted for the study (Buchanan & Hvizdak, 2009:37; Gray, 2013:29). The researcher perceives reality as predictable but imperfect (Buchanan & Hvizdak, 2009:37; Gray, 2013:26), which aligns with the traditional objectivist approach of positivism (Cohen et al., 2000:6).

This study adopted a non-experimental quantitative methodology to collect the required data (Harwell, 2011:149; Muijs, 2013:11). The researcher employed a web-based questionnaire to measure opinions and present responses as numerical data (Ary et al., 2014:399; Buchanan & Hvizdak, 2009:37). To collect more data, the survey used in this study also used a concurrent, embedded design which provided participants with the opportunity to respond to open-ended questions and provide comments to supplement the numerical data (Cohen et al., 2000:255). This additional data were compared to the primary quantitative findings and were used to reinforce the findings and identify possible inconsistencies in the findings.

Quantitative survey methods can generate copious amounts of data which, after analysis, should be given meaning by the researcher based on what is known about the topic (Field, 2009:3). Additionally, data analysis considers different interpretations and relates the findings to those of other similar studies (Choy, 2014:99).

3.3 DEVELOPMENT OF THE RESEARCH QUESTIONNAIRE

3.3.1 Introduction

The data collection instrument for the empirical phase of the study was a self-developed questionnaire administered as a web-based survey (Julien, 2008:846). Questionnaires are normally used to collect information such as facts, opinions,
perceptions, attitudes and expectations from targeted participants (Siniscalco & Auriat, 2005:4). Data collected by implementing questionnaires relies on the principle that for each separate data collection exercise, each participant must be presented with the same set of questions and the collected responses must then be analysed using the same method or technique (Siniscalco & Auriat, 2005:3) to translate that set of data into information (Creswell, 2012:376). For example, surveys are helpful when the need is to describe or identify attributes; in the case of this study, the required generic and discipline-specific attributes of South African food scientists and technologists (Ary, et al., 2014:412; Creswell, 2012:376).

Before deciding on the questionnaire as a data collection instrument, it was determined that there was no available data applicable to this study. The attention shifted to sourcing existing questionnaires that may be suitable for the purposes of the study. Although several general employability questionnaires were identified and scrutinised for suitability, they were mainly generic in nature and too broad to be applicable to answer the specific research sub-questions of this study. Likewise, examples of food science and technology-specific questionnaires were sourced. One such questionnaire was sourced from the Department of Food Technology at the Cape Peninsula University of Technology (CPUT, in South Africa). This questionnaire was developed based on the IFT guidelines and 'core competencies' (IFT, 2011:7) described earlier (refer to section 2.3.4.1). The purpose of the questionnaire was to consult stakeholders about curriculum matters related to the food technology programmes offered within the specific department of CPUT. The information gathered was to be used when developing the curriculum for new qualifications which must align with the requirements of the Higher Education Qualifications Sub-Framework (SA DHET, 2014:13). This questionnaire consisted of the following sections: Demographics of the respondents, including name and contact details; years of work experience and highest academic qualification; general skills, including communication, professionalism and interactive skills, people skills, thinking skills, and organisational skills; and lastly, technical food science and technology knowledge, skills and competencies. On completing this questionnaire, it became clear to the researcher that the rating scale used was inadequate and sometimes even confusing in terms of collecting data needed for this study.
Another potential questionnaire was made available by the Department of Food Science at the University of Pretoria, South Africa. The purpose of this questionnaire, which was circulated in 2002, was to gather data to determine how the department could improve and add value to the graduates of the department to better meet the requirements of the stakeholders. This questionnaire included collecting the participants’ details; a description of the participants responsibilities and key performance areas; a section on technical skills, including food chemistry and analysis, food safety and microbiology, food processing and engineering, and applied food science; a short section on ‘soft skills’ and ‘business skills’; followed by three open-ended questions. Respondents were requested to rate the technical, soft and business skills according to importance by selecting a value between one (not important at all) and 10 (extremely important). In addition, the respondents were also asked to give a rating of their own abilities for each of the skills provided and/or the perceived abilities of the graduate food scientists and technologists employed by industry stakeholders.

Both described questionnaires relied heavily on the IFTs’ (2011:6-8) guidelines for ‘core competencies’, and technical food science and technology skills as applicable at the time of drafting the questionnaires. After consideration, it was decided that neither of these questionnaires was sufficiently comprehensive or adequately targeted the purposes of this study. Therefore, the logical alternative was to develop a questionnaire specific to this study in “focus and scope” (Ary et al., 2014:400).

The draft questionnaire was developed in three stages, which will be subsequently described in more detail, as follows:

- Firstly, the theoretical development of the draft questionnaire;
- secondly, the streamlining and confirmation of the draft questionnaire; and
- thirdly, the finalisation of the questionnaire.
3.3.2 The theoretical development of the draft questionnaire

The first stage of developing the questionnaire was based on an extensive review of the literature about generic graduate attributes and the related concepts of employability, graduateness and personal attributes; specifically, the essential knowledge, skills and competencies expected from food scientists and technologists. The literature review was aided by ATLAS.ti software to manage and code the literature. Coding was inductive or ‘open’, allowing the researcher to become familiar with the discourse and to find themes for inclusion in the questionnaire (Bernard, 2006:493). Previously described required skills, knowledge and competencies specific to food science and food technology graduates formed the framework for the discipline-specific content of the literature review (see 2.3.4).

The sections proposed in the draft questionnaire, loosely based on the categorisation of Saunders and Zuvel (2010: Phase 1: Employability skills questionnaires) and Ho et al. (2011:9-11) included sections dealing with:

- generic ‘non-discipline’ graduate attributes, including those associated with employability and graduateness (refer to Table 2.3);
- personal attributes, including qualities and attitudes to successfully engage with the world (refer to Table 2.3); and
- food science and technology-specific knowledge, skills and competencies to ‘do the job’ (refer to Table 2.2).

The draft questionnaire reflected not only aspects found as relevant from the literature, but also from the examples of food science and technology-specific questionnaires described previously. In addition, the draft questionnaire echoed the researcher’s own values, experience and beliefs. Once the draft questionnaire was developed, it was presented to a focus group for discussion and refinement as described next.
3.3.3 Streamlining the draft questionnaire

Streamlining the questionnaire consisted of two steps. Firstly, a focus group of experts was used to confirm the content and structure of the draft questionnaire. Once the questionnaire was adapted to capture the focus group discussions, it was converted into a web-based survey and was then piloted to identify any further refinements.

3.3.3.1 Focus group

Streamlining and confirming the content of the draft questionnaire was done by using a focus group discussion which allowed in-depth discussions around the content and invited opinions from participants considered as experts in their respective fields in food science and technology (Bernard, 2006:232; Côté-Arsenault & Morrison-Beedy, 1999:280; Morgan, 1997:33). These discussions allowed for interaction between the participants, which is reported in literature to generate trustworthy findings (Houliez & Gamble, 2012:32; Rauf, Baig, Jaffery & Shafi, 2014:28). Tynan and Drayton (1988:8) propose that “rigorous sampling, honest recruiting and careful moderation” will enhance the validity of the focus group findings. A single, face-to-face focus group discussion was used for this study seeing that the purpose of the discussions served to refine and confirm the content and structure of the draft questionnaire to ensure it was fit for purpose (Bernard, 2006:233; Morgan, 1997:33).

a) Participants: focus group

Identifying key participants who could provide useful and representative input was essential to achieve the purpose of the focus group discussions (Ary et al., 2014:163; Bernard, 2006:191; Côté-Arsenault & Morrison-Beedy, 1999:281; Creswell, 2012:143; Morgan, 1997:38; Ritchie et al., 2003:78-7). Consequently, focus group participants were purposively selected from the population relevant to this study (refer to Table 3.4) using predetermined criteria, before an invitation was sent to them to participate (Morgan, 1997:39; Ritchie et al., 2003:78).

The selection criteria included: Expertise based on qualifications and experience in food science and technology; employers of food scientists and technologists;
representation of key constituencies and stakeholder groups; representation of the interests of different sectors of the food industry, such as dairy, meat, and fresh produce; involvement in food science and technology-related company graduate programmes; and/or teaching and learning initiatives within the discipline of food science and technology. In addition, participants were recruited only from the Gauteng Province to circumvent possible travel and accommodation costs associated with taking part in the discussion. Accordingly, each of the ‘recruited’ participants showed the specific background and characteristics required to ensure that the interests of pertinent societal stakeholders were broadly represented (Cohen et al., 2000:288; Côté-Arsenault & Morrison-Beedy, 1999:281). Where possible, the choice was achieved by contacting the stakeholder group rather than an individual directly and asking them to propose the names of possible participants that they felt would represent their interests. On receiving the proposed participants’ details from the pertinent stakeholder categories, these were matched against the categories in Table 3.4 to ensure broad representation.

Once possible participants were identified they were contacted telephonically or electronically to explain the purpose of the focus group and ascertain if they would be willing to participate. Following this, an invitation was sent to willing participants which contained an overview of the research study, the purpose of the focus group, and details of the focus group date, venue and time (refer to Annexure C). Snowball sampling (Bernard, 2006:193; Côté-Arsenault & Morrison-Beedy, 1999:282) was used to identify and invite additional participants to ensure that the identified constituencies were represented. Two potential participants contacted the researcher directly to express interest in taking part in the discussions. More focus group participants were invited than needed to plan for the inevitability that some participants would not attend (Côté-Arsenault & Morrison-Beedy, 1999). Ultimately, 15 invitations were accepted to participate, of which 13 participants, including the two participants who had contacted the researcher directly, were present in the discussions. The final composition of the 13 participants is detailed in Annexure D.

Unfortunately, although they accepted the invitation to participate, the participants invited to represent the interests of the meat sector, food safety, and food product development were unable to attend. There were, however, participants present at the
focus group discussions who had expertise and experience in these areas, and they were able to provide valuable opinions and comments on these areas. There was also no nutritional expert present in the focus group discussions, but many of the participants had nutritional expertise. It is acknowledged that due to the purposive and snowball sampling approach used to identify potential participants, some participants may have been known to one another. However, rather than having a negative influence this assisted in facilitating the discussions.

b) Conducting the focus group

The discussions followed a semi-structured format, which allowed the content and structure of the draft questionnaire to be discussed systematically. This allowed participants the opportunity to share their opinions and perceptions on each item, and to enter into discussions with one another and the researcher (Bell, 2010:166; Côté-Arsenault & Morrison-Beedy, 1999:280). Based on the discussions, omissions were identified, content was consolidated, redundant content removed, and sources of errors were eliminated or minimised as far as possible. Apart from refining, clarifying and evolving the questionnaire content, the phrasing of the questions and suitability of the rating scales were also discussed. In this way, the content validity of the developed questionnaire and its suitability in the context of this study were answered.

The site selected for conducting the focus group came at no cost as it was located at the University of Johannesburg, Doornfontein Campus, South Africa. This campus has easy access from the surrounding areas and ample parking. The participants were sent a follow-up e-mail reminding them of the focus group discussion at the beginning of the week in which the discussion was held, together with directions and a map to the campus and the venue. The timing of the focus group discussion was planned to ensure that travelling to and from the venue was not unduly influenced by peak traffic patterns. As it coincided with lunchtime, the participants were provided with refreshments and a light lunch. Other than that, there was no incentive for taking part in the focus group discussion.

When conducting focus groups for research purposes, it is recognised that pre-preparation is essential to collect quality data (Morgan, 1997:37). This pre-preparation
applies not only to the researcher, but also to the participants. To afford the participants the opportunity to prepare for the focus group discussion, the draft questionnaire was pre-circulated on acceptance of the invitation to participate in the focus group. This also allowed the participants to deliberate the graduate capabilities expected of food scientist and technologists with their colleagues prior to the focus group.

The focus group structure followed the guidelines suggested by Côté-Arsenault and Morrison-Beedy (1999:280). At the start of the discussion, the researcher welcomed the focus group participants, presented an overview of the research study and reinforced the purpose of the focus group. Issues of ethics and confidentiality associated with the focus group discussions were highlighted, and the right for participants to withdraw at any stage of the discussions was reinforced. A copy of the introduction, a list of the names and affiliations of the participants (refer to Annexure E), together with a copy of the draft questionnaire, were provided to the participants. The participants were encouraged to make notes on the copy of the draft questionnaire provided to them at the start of the meeting. These copies were collected at the end of the discussion with the consent of the participants and screened for any additional comments that participants may not have wanted to share or did not have the opportunity to share with the group. At the start of the discussions, the participants, including the researcher, introduced themselves to the group. Discussions were opened after permission was obtained from the participants to voice record the session for possible transcription later.

The discussions followed a ‘funnel approach’ which encourages free-discussion followed by a more focused discussion of certain sections and questions (Morgan 1997:41). To achieve the purpose of the discussions, the order of the draft questionnaire – from the general to more specific food science and technology content – was followed. The purpose of the discussions dictated that after each discussion, consensus between the participants was needed before the discussion moved to the next item (Creswell, 2012:384). Conducting the focus group discussions in this way required careful management of the group dynamics to ensure that no individual participant, or the researcher’s views and beliefs, influenced the consensus reached (Creswell, 2012:384). The discussions followed the recommendations of Côté-
Arsenault and Morrison-Beedy (1999:280), such as setting up commonality between the participants, directing all questions to the group and not to individuals, and providing each participant with the opportunity to provide input. Tangent conversations within the group were managed by the researcher, as this would make transcribing the recorded discussions difficult (Creswell, 2012:218).

In addition to digital voice recordings, the researcher also made detailed field notes that were later compared to the content of the discussion transcripts to ensure agreement. Côté-Arsenault and Morrison-Beedy (1999:280) mention that participants may suffer from fatigue and become “tired, bored or overloaded” after lengthy discussions. Towards the end of one and a half hours, participant fatigue became evident and the discussion was closed. The researcher asked permission to contact the participants directly if any further expertise was required pertaining to the learning outcomes of the discipline-specific content of the survey. An e-mail was sent to each of the participants the day after the discussions to thank them for their time and to acknowledge their contribution.

Trustworthiness and thoroughness were essential to ensure the credibility of the focus group discussions (Ary et al., 2014:531; Côté-Arsenault & Morrison-Beedy, 1999:281; Leech, Dellinger, Brannagan & Tanaka, 2010; Ritchie et al., 2003:270). A potential source of bias was possible, as some of the focus group participants were acquainted with each other and/or with the researcher. However, bias is only a problem if the potential source is not effectively managed and the interpretation of the data collected during the discussions does not reflect the complete range of opinions (Morgan, 1997:6). In the context of this study, the purpose of the focus group dictated that minimal bias would be introduced, on condition that the group dynamics were managed by the researcher.

The section of the draft questionnaire dealing specifically with nutritional knowledge was sent to a food technologist who also holds a qualification in dietetics to screen for correctness and completeness. This circumvented the absence of a nutritional expert in the discussions. This input was then tabled during the focus group discussions. Morgan (2008:353) mentions that different data may be collected from the same participant in an individual interview compared to the data collected in a focus group.
However, the validity of focus group discussions ultimately related to the purpose of the discussions (Bernard, 2006:237). The purpose of this focus group was to confirm the questionnaire content, rating scale, layout and length, and the question phrasing through consensus rather than reflecting the participants’ personal views or collecting data related to differences in opinions.

3.3.3.2 Findings in respect of the focus group

The focus group was conducted during the development phase of the questionnaire to confirm the content, phrasing of questions, objectivity and the format developed through the literature review (refer to Tables 2.2 & 2.3). Initially, the draft questionnaires collected from the participants after the focus group discussions were screened and all ‘anonymous’ written comments were recorded and combined with the researcher’s field notes. The duplicate voice recordings were both of mediocre quality due to the background noise of a fire alarm; to obtain additional information, professional enhancement was required for the recordings to be successfully transcribed. Once transcribed, the field notes taken during the discussions were cross-checked against the transcription. The stakeholder category of the participants was then assigned to the transcription and any anonymous written comments from the collected draft questionnaires were added to the relevant section or item. The transcription was then manually analysed using content analysis and then compared to the consensus reached and recorded in the field notes.

There was much discussion about the length of the questionnaire as the draft consisted of 18 pages. Once converted into a web-based survey, it would be very lengthy and could result in participant fatigue (Van Selm & Jankoski, 2006:441). Ary et al. (2014:254 & 432) link the length of a survey, together with participants’ interest, attitude and incentive towards the study, with the response rate of a survey. Fan and Yan (2010:133) name survey length as an important consideration in response rate and suggest that as the length of the survey increases, the response rate decreases. Consequently, the possibility of sending out two shorter surveys rather than one long survey was discussed. The focus group’s consensus was that one long survey was better in this instance. The motivation for this choice was that the target population is a small, close community and the topic of the study was of interest to most of the
potential participants. It was agreed that the length of the survey could be offset by making questions optional rather than compulsory, thus allowing participants the flexibility to give their opinions. This decision is supported by the views of Newcomer, Hatry and Wholey (2015:368), who mention that although lengthy surveys are usually linked to lower response rates, this is not necessarily always the case. The response rate is also influenced by factors such as the participants’ interest in the topic and their motivation to be involved in the study.

3.3.4 The final questionnaire

The draft questionnaire discussed at the focus group discussions was amended and consolidated to reflect the outcomes of the discussions. The final questionnaire consisted of seven sections and 78 questions (refer to Figure 3.3 and Table 3.2), some of which had sub-questions (refer to Annexure F).

3.3.4.1 Nature of the questions

The questionnaire assumed a predominantly quantitative approach making primary use of fixed-choice closed-ended questions implementing a corresponding rating scale (Julien, 2008:846; Saunders et al., 2009:374). Table 3.2 provides an overview of the questions contained in the final questionnaire.

The first section of the questionnaire collected background information which was used for filtering purposes to exclude those participants who might not have the required work experience to provide useful data. In addition, the information collected allowed stratification of the data.

The next four sections of the questionnaire consisted of three basic categories of attributes, namely generic graduate attributes, personal attributes and two sections probing food science and technology-specific requirements (Saunders & Zuvel, Phase 1: employability skills questionnaire, para. 1).
Figure 3.3: Final structure of the questionnaire

The theoretical basis for the content of the first section (Section 2) that probed the perceived generic graduate attributes, and the section (Section 3) probing the perceived personal attributes are shown in Table 2.3. Sections four and five dealt with those discipline-specific knowledge skills and competencies perceived as necessary requirements to practice as a food scientist or technologist (refer to Table 2.2). At the start of section four, the participants were asked to select their career category from the following options: ‘Food Scientist’, ‘Food Technologist’, or ‘Other’. Following this, each of the 13 fundamental discipline areas identified as appropriate to the study (refer to Table 3.2 & Figure 3.4) was probed by providing several comprehensive learning outcomes linked to a six-point Likert-type rating scale (refer to 3.3.4.2). The optional choice of completing the questions in the section was highlighted at the start of the section with a short motivation for why participants should take the time to complete it.
Table 3.2: Overview of the structure of the final questionnaire

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions with answer choices provided</th>
<th>Questions requiring a written answer</th>
</tr>
</thead>
</table>
| Section 1: Demographics and general | • Gender  
• Highest level of education  
• Current employment status  
• Geographical area of employment  
• Total years of work experience  
• Employment sectors with a minimum of one year of experience  
• Areas in food, beverage and related industries with more than one year of experience | • Name of qualification/s and institution/s  
• Current job title / short job description/ level of involvement in FST |
| Section 2: Employability / employability skills (refer to Table 2.2) | • General employability skills  
  o Communication – written, verbal  
  o Most important language/s  
• Management and leadership  
• Diversity management skills | • Other – please specify  
• Other – please specify  
• Other – please specify  
• Other – please specify  
• Additional comments on employability attributes expected on employing a FST. |
| Section 3: Personal attributes (refer to Table 2.2) | • Personal qualities, dispositions, emotional intelligence, intellectual skills | • Other – please specify  
• Additional comments on personal attributes expected when employing a FST |
| Section 4: Food science and technology fundamental academic and professional understanding, skills and competencies (refer to Table 2.2) | • There were 12 areas of fundamental skills identified, including  
  o Food analysis (analytical, biochemical and chemical)  
  o Sensory analysis  
  o Food chemistry  
  o Nutrition  
  o Food regulation and control including legislation  
  o Food microbiology, general microbiology and microbial analysis  
  o Food packaging  
  o Food processing  
  o Food engineering  
  o Food product development | • Other – please specify  
• General comments on each were invited |
### Section 1: Overview

- **Questions with answer choices provided**
  - Food safety and quality management
  - Applied FST
- **Questions requiring a written answer**
  - Participants were asked to select a category of respondent i.e. FS, FT or Other
  - Rank the 12 provided areas of fundamental skills in order of importance with 1 = most important and 12 = least important
  - Further to this, the required learning outcomes for each were probed

### Section 2: Specific Sector Details

- **Section 5: Broad sector-specific expectations**
  - The participants were provided with a list of 20 food specific sector/commodity areas, such as dairy, meat, beverages, and asked to rate the importance of each
  - Other – please specify
  - General comments regarding sector-specific skills invited

- **Section 6: Last section / conclusion**
  - Usefulness of work-integrated learning (WIL), 'in-service', work experience, etc. in developing employability attributes (essential or very useful, undecided, not at all useful)
  - Asked to differentiate between a FS and FT and what each should be able to do when entering employment
  - Comments on usefulness of WIL
  - What are the skills acquired during WIL, 'in-service', work experience, etc.
  - Period recommended in weeks or months

### The end of the survey – thanks for participating in the survey

- Contact details if prepared to participate in a subsequent phase
The final structure of section five, probing the essential food science and technology knowledge, skills and competencies, is shown in Figure 3.4 in the order of appearance in the final survey.

**Figure 3.4:** Fundamental areas of food science and technology knowledge, understanding, skills and competencies presented in the survey

The focus group discussions highlighted the value of work placement in developing food science and technology students prior to graduating. The final section of the questionnaire closed the survey and thanked the participants. Therefore, the sixth section of the questionnaire investigated two aspects, namely:

- the perceived value of work placements and work-integrated learning in enhancing the required food science and technology-specific graduate attributes; and
- the perceived difference between a food scientist and a food technologist.
The final section of the questionnaire thanked the participants for their participation and asked for their contact details should they agree to be contacted at a later stage to collect additional data related to this study.

To add another dimension to the data collection by implementing the questionnaire, text data were also collected by using open-ended questions and comment boxes. This is referred to as a ‘semi-closed’ question format (Creswell, 2012:628). The open-ended questions were of two types; either ‘Other – please specify’ or extension questions. These questions allowed the participants the opportunity to add to those themes not presented in the fixed-question options captured in the questionnaire (O’Cathain & Thomas, 2004:6). The second type of open-ended question appeared at the end of each section/subsection and asked for additional general comments. The use of open-ended extension questions was used to make sure that relevant food science and technology knowledge, skills and competencies had been captured in the survey questions (O’Cathain & Thomas, 2004:4). The general comments allowed for the reliability and validity of the quantitative data findings to be confirmed and enriched through comparison (Cohen et al., 2000:275; O’Cathain & Thomas, 2004:4; Skinner, 2008:449). Although including the ‘Other’ option and general comment boxes resulted in varied responses which were sometimes difficult to analyse (Ary et al., 2014:418), additional and valuable information was obtained.

3.3.4.2 Rating scale

The final questionnaire (refer to Annexure F) made use of a six-point Likert-type rating scale to collect quantitative data based on respondents’ opinions and perceptions (Ary et al., 2014:231; Holmes, 2013:1048-9). Likert-type scales have both strengths, such as simplicity and reliability, and weaknesses, such as the occurrence of central tendency and response bias (Bertram, n.d.:4; Knafl, 2008:89). The construction and reliability of the rating scale are essential to ensure the rigour of the collected data (Ary et al., 2014:229). A six-point Likert-type rating scale was used for the sections investigating the required generic graduate attributes, personal attributes and food science and technology-specific knowledge, skills and competencies (Addendum E, sections 2, 3, 4 5 & 6; see Table 3.3) as it forced the respondent to make a choice, either ‘positive’ or ‘negative’ (Ary et al., 2014:226; Bertram, n.d:1; Cohen et al.,
The six-point Likert-type rating scale was represented as a graphic scale of descriptions ranging from 'Not at all important' to 'Extremely important', as shown in Table 3.3.

<table>
<thead>
<tr>
<th>Weighting value</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response category</td>
<td>Not at all important</td>
<td>Low importance</td>
<td>Slight importance</td>
<td>Moderately important</td>
<td>Very important</td>
<td>Extremely important</td>
</tr>
</tbody>
</table>

For data analysis to identify the graduate capabilities required by food science and technology graduates, the response categories must be weighted with the most positive response, in this survey 'extremely important', having the highest weighting value (Ary et al., 2014:227). A point of contention is that Likert-type response categories provide ordinal data, seeing that it cannot be assumed that equal sized intervals exist between the scales (Jamieson, 2004:1217); from a statistical viewpoint, this is an important consideration when analysing the data. To analyse the collected data by implementing the questionnaire in this survey, the rating statements were linked to numerical weightings for analysis; however, these numerical values were not visible to the participants. This is termed a 'quasi-interval' by Creswell (2012:167), who promotes that data collected without a visible numerical interval can be analysed as both ordinal and interval data, seeing that the error introduced by doing this is relatively small. Despite support for this viewpoint, it is controversial (Jamieson, 2004:1217). The quantitative data collected through this survey was analysed as ordinal data using descriptive statistical techniques (Bertram, n.d.:2; Jamieson, 2004:1217); to a large extent, it was limited to frequency analysis (Jamieson, 2004:1217). The rating scale was uniform for the complete survey to limit confusion by the participants, and to ensure consistency of their responses.

3.3.5 Concluding remarks

In summary, a deductive approach was adopted to develop a draft questionnaire based on an extensive review of relevant literature and reflecting the researcher’s own
experience, beliefs, perceptions and views. The draft questionnaire was presented to a focus group for discussion, critical scrutiny and refinement of the content, length and structure. The redrafted questionnaire consisted of six broad sections. Each section dealt with themes that were listed, grouped together and rationalised to represent an overview of the graduate capabilities that could reasonably be seen to apply to food science and technology graduates.

After redrafting the questionnaire based on the input and guidance of the focus group participants, the questionnaire was converted into a web-based format using a commercially available survey development tool, SurveyMonkey® before piloting it (refer to 3.5.3).

3.4 RESEARCH PARTICIPANTS AND ETHICAL MEASURES

Sampling entails selecting those participants identified as relevant to the context of the research study from a bigger population (Ary et al., 2014:161; Cohen et al., 2000:92; Creswell, 2012:142; Palys, 2008:697). Two categories of sampling, probability and non-probability sampling, are recognised (Ritchie et al., 2003:78). Rather than a randomly selected sample, non-probability sampling was used in this study, namely a purposive “stakeholder sampling” approach (Palys, 2008:697). The purposive approach included some elements of theoretical sampling to identify and ensure as wide a rate of participation as possible to represent the various stakeholder interests (Ary et al., 2014:163-170; Babbie & Mouton, 2011:166; Creswell, 2012:143; Henning, van Rensburg & Smit, 2004:71; Ritchie, et al., 2003:78). Selecting participants in this way, according to pre-determined criteria and categories, is also termed segmentation or stratification (Morgan, 1997:7), which is useful in data analysis (Bhaskaran, 2010:26). Table 3.4 provides details of the key constituencies, or stakeholders identified as necessary to ensure effective outcomes for this study. In addition, various sectors of the food and allied industries, such as dairy, meat, and alcoholic beverages, who may have different requirements from newly employed graduates, were also identified.
Table 3.4: South African food science and technology societal stakeholders

<table>
<thead>
<tr>
<th>Stakeholder group</th>
<th>Possible participant(s)</th>
<th>Rationale for inclusion</th>
</tr>
</thead>
</table>
| **Government departments and organisations** | - Dept. of Health (DOH), Directorate of Food Control  
- Dept. of Agriculture, Forestry and Fisheries (DAFF), Chief Directorate: Inspection and Quarantine Services, Directorate: Food Safety and Quality Assurance  
- Agricultural Research Council (ARC)  
- Council for Scientific and Industrial Research (CSIR), Food Research Institute (FRI)  
- FoodBev Seta | - The DOH and DAFF employ or rely on food scientists and technologists for expert input when formulating legislation related to the agricultural, food and related industries as well as the implementation and compliance to legislative requirements.  
- The ARC and CSIR provide services and consultancy to agricultural, food and related industries thus employing and interacting with food scientists and technologists to research, develop and implement food science and technology strategies.  
- FoodBev is a sector education and training authority (SETA) mandated to implement the National Skills Development Strategy (NSDS) and to promote and facilitate skills development in the food and beverages manufacturing sector. |
| **Non-government organisations representing food science and technology interests** | - South African Association for Food Science and Technology (SAAFoST)  
- South African Association of the Flavour and Fragrance Industry (SAAFFI) | - SAAFoST is an association for food professionals. It has different classes of membership namely, individual (including student), institutional and custodian members.  
- SAAFFI is an association for the manufacturers and suppliers of flavours and/or fragrances which in turn employ food scientists and technologists. |
| **Higher education** | Departments of food science and technology at SA universities (see Annexure M) | Involved with the education and training of food scientists and technologists for the SA food, beverage and related industries. Many are food scientists and technologists themselves, some have expertise in a specific area of discipline-specific knowledge, skills and competencies. They interact with the employers of food scientists and technologists and understand the shortcomings of graduates when they enter postgraduate studies. |
| **Food scientists and technologists** | - Members of SAAFoST including professional, ordinary institutional and custodian members, excluding student members  
- Minimum of 12 months of employment | Food scientists and technologists are considered able to provide input into the required graduate capabilities to be successful in employment in the food, beverage and allied industries. May have broad experience representative of different food sectors such as meat, dairy, and baking. |
| **Employers of food scientists and technologists** | Participants from different segments of the food, beverage and/or related industries such as dairy, meat, poultry, alcoholic and non-alcoholic beverages, ingredients and raw material suppliers, and retailers | Employers of food scientists and technologists from various food, beverage and allied sectors who know what they need and expect from newly graduated food scientists and technologists when the employ them. May not be food scientists and technologists themselves. |
More specific details of the focus group participants have been provided previously (see 3.3.3.1 a). Further details of the survey participants are provided in a subsequent section (see 3.5.4).

3.4.1 Ethical measures and clearance

Ethics indicate “appropriate conduct” to limit harm and safeguard the well-being of others (Preissle, 2008:273). Ary et al. (2014:623) summarise the ethical principles of research as including the professional competence and integrity of the researcher; professional, scientific and scholarly responsibility; the respect of people’s rights; dignity and diversity; and social responsibility to make the findings of the research public.

This study employed a non-probability sampling technique to select both the focus group (see 3.4.1) and the survey participants (see 3.4.2). All recruited participants were 18 years or older due to the selection criteria used. The data collection instrument used during the first phase of the study was a self-developed questionnaire administered using a commercially available survey tool. To exclude students from taking part in the survey, a filter question which required participants to have at least one year of work experience was included at the start of the survey. Other ethical measures implemented were based on generally recognised best practice to cause no harm to the participants (Dhai & McQuoid-Mason, 2010:14; Booth et al., 2008:273; Preissle, 2008:274-7).

Prior to the commencement of data collection, ethical approval for conducting the study was obtained from the Faculty of Education’s Ethics Committee as per the University of Johannesburg and Faculty of Education requirements (refer to Annexure A). Both the focus group discussions and the web-based survey embedded ethical choices in the design and implementation (Buchanan & Hvizdak, 2009:37). To ensure ethical conduct, the four normative ethical principles of Dhai and McQuoid-Mason (2010:14) of autonomy, justice, non-maleficence and beneficence were incorporated into this study as described next.
3.4.1.1 Autonomy

The right to agree to participate in the focus group discussions was based on an informed decision by the participants who were provided with the following information: The aim of the research, the purpose of the focus group, and an outline of the process to be followed (refer to Annexures C and E). Likewise, for participation in the web-based survey participants were provided with information in the electronic invite to make an informed decision about their voluntary participation in the study (see Annexure G). Once a potential participant accessed the survey via the hyperlink, an introduction to the survey was provided (refer to Annexure F). This introduction reinforced the purpose of the study and that participation in the survey was voluntary, allowing the participants to make informed decisions before continuing with the survey.

3.4.1.2 Justice

The focus group participants’ right to withdraw at any time without any consequence was included in the invitation (refer to Annexure C). It was also reinforced at the welcome and by way of the instructions provided at the commencement of the focus group discussion (refer to Annexure E). During the discussions, the input of each member of the focus group was encouraged and reinforced as valuable and equal.

The confidentiality and privacy of the survey participants were ensured by collecting the data anonymously. Additionally, the responses to the survey constructs were optional and not compulsory. This allowed participants the freedom to by-pass questions without forcing a response. Each page of the survey questionnaire provided participants with the opportunity to exit the survey without prejudice.

3.4.1.3 Non-maleficence

At the start of the focus group discussions, participants were requested to respect the confidentiality of the group discussions. This was necessary, as focus group discussions were between the group participants and the researcher (Morgan, 1997:32). During the discussions the participants were afforded the opportunity of
expressing their views and opinions without criticism from the other members of the group or the researcher.

The integrity of the survey findings based on the data collected was ensured through logical and systematic data analysis based on best practice.

3.4.1.4 Beneficence

The findings and outcomes of this study will be disseminated through publications, the planned workshops for the academic staff teaching food science and technology students and conference presentations. A conference presentation was presented to the members of the South African Association of Food Science and Technology in September 2015 to report the findings of the situation analysis. The conference presentation did not name the participants and care was taken not to cause participants any harm.

3.5 THE WEB-BASED SURVEY

3.5.1 Introduction

The empirical phase of this study collected data by conducting a web-based survey (Bell, 2010:12; Siniscalco & Auriat, 2005:3) that implemented a self-developed questionnaire (refer to 3.3.4) with the purpose of collecting contributions from ‘relevant’ South African stakeholders. The survey aimed to collect data that could be used to indicate the level of importance of different aspects of graduate capabilities. Based on these findings, a profile of what is required from food scientists and technologists as perceived by relevant societal stakeholders could then be developed. The survey collected primarily quantitative data using closed questions linked to a pre-determined six-point Likert-type rating scale (see Table 3.3). Concurrently, by using the same questionnaire, responses to open-ended questions and comment boxes were collected by allowing participants the freedom to express themselves to enhance the completeness of the findings (Ary et al., 2014:245; Cohen et al., 2000:255; Creswell, 2012:624; Siniscalco & Auriat, 2005:26). The survey was cross-sectional and collected
data based on opinions, perceptions, or beliefs at one point in time (Creswell, 2012:377; Julien, 2008:846).

3.5.2 Administration of the web-based survey

Questionnaires can be administered in several ways, such as mailing the questionnaire, presenting the questionnaire at a face-to-face interview or focus group, or telephonically (Ary et al., 2014:412; Creswell, 2012:376). However, increasingly, use is made of electronic administration of the questionnaire where the questionnaire is either e-mailed to the participants or is administered as a web-based survey. This study made use of a web-based survey which was accessed via a hyperlink in the e-mail invitation. Administering a questionnaire in this way has many advantages, such as collecting data directly from a large sample of participants in different geographical areas, reduced costs, immediate delivery, participant anonymity and ease of administration and data storage (Ary et al., 2014:414; Creswell, 2012:383; Buchanan & Hvizdak, 2009:37; Cunningham, Quan, Hemmelgarn, Noseworthy, Beck, Dixon, Samuel, Ghali, Sykes & Jetté, 2015:15; De Leeuw & Berzelak, 2016:143; Fan & Yan, 2010:132). Participants were also able to respond at their convenience to the questions posed in the questionnaire (Van Selm & Jankoski, 2006:438).

Using a web-based survey limits any potential direct influence that the researcher may have over the participants’ responses as there is no need to directly interact with participants (Buchanan & Hvizdak, 2009:37). Furthermore, the responses to web-based survey questions are usually frank and less guarded as the data collected is generally from anonymous respondents (Ary et al., 2014:413). Surveys could also allow for the collection of participants’ contact details to later follow up with them individually (Ritchie et al., 2003:91), a strategy that was employed in this study by allowing participants the option to leave their contact details at the end of the survey.

Weaknesses associated with web-based survey methods include poor response rates and lack of representativeness, which is a big concern when dealing with probability samples, due to factors such as differences in access to the internet (Ary, et al., 2014:413; Cunningham et al., 2015:16; De Leeuw & Berzelak, 2016:145; Fan & Yan, 2010:134). The appearance, length of the survey, format, structure and phrasing of
the questions also influence the overall response rate and must be planned with care (Ary et al., 2014:423-5; Harwood, 2010:173). In addition to non-response errors, sampling errors, measurement errors and coverage errors are also associated with web-based surveys (Creswell, 2012:282). Consequently, adopting a web-based survey as the data collection mechanism for this study required careful consideration by the researcher of the associated weaknesses and the implementation of strategies to limit potential bias and to encourage the collection of inclusive and representative data (Fan & Yan, 2010:134).

Non-response errors were addressed by implementing strategies to encourage participants to take part in the survey (Ary et al., 2014:431-433; Sauermann & Roach, 2013:285). This included sending a personalised introductory letter to potential participants explaining the purpose of the survey prior to sending the invitation to participate in the survey (Ary et al., 2014:417). Sampling errors were addressed by adopting a rigorous sampling approach to select the required participants by including filter questions and ‘skip logic’ (Hewson, 2015:282) at the start of the survey to exclude those participants who did not meet certain criteria for participation. In addition, a segmentation question ensured the inclusion of all three career categories, namely ‘Food Scientists’, ‘Food Technologists’ and ‘Other’.

Measurement errors can be introduced by missing data and data that is difficult to categorise, therefore, surveys from participants with excessive missing response data were excluded from the data analysis (Creswell, 2012:387). The inclusion of some rephrased and repeated questions was used to ensure internal consistency of the responses to the survey (Ary et al., 2014:436). Coverage error could be introduced into a web-based survey when the sample population does not have equal access to the internet (Fan & Yang, 2012:134; Julien, 2008:848). Most of the target population were employed and adequate internet access could be assumed, which may have limited bias introduced by coverage error (Fan & Yang, 2012:134; Julien, 2008:848).

To encourage participation and completion of the survey, the survey questions were optional rather than compulsory. This choice allowed the participants the flexibility to choose to respond to a question or move on to the next question or section. It also allowed participants the opportunity to give more input into areas in which they had
greater expertise, and not to provide responses in areas where they had little or no experience and/or expertise. In addition, this study adopted several strategies to increase response rates as outlined by Sauermann and Roach (2013:285). These strategies included sending a few reminders to take part in the survey, each having a different format, wording and layout, and choosing different days and times to send the reminders (see Annexure G).

3.5.3 Piloting of the web-based survey

Once the content of the draft questionnaire was finalised based on the input from the focus group, the questionnaire was converted to a web-based format using the commercially available online survey construction tool SurveyMonkey®. Piloting the web-based questionnaire developed for this study was the final developmental stage. Part of the purpose of piloting the questionnaire was to ensure that the web-based questionnaire appeared correctly on the computer screen and that the layout followed a logical sequence. The purpose thus dictated that piloting the questionnaire had to be done online.

A total of seven purposively selected food scientists and technologists who had graduated and worked in South Africa before moving abroad to take up employment, were identified as the participants for piloting the web-based questionnaire. These participants were each invited personally via e-mail or through telephonic contact to explain the aims of the study and the purpose of piloting the questionnaire. Once the participant agreed to contribute to the piloting of the questionnaire, the next step was sending them an electronic letter of introduction and formal invitation, together with a hyperlink to allow them access to the questionnaire. More information was also asked for, such as comments on the appropriateness of the rating scale, any obvious errors, and suggested refinements, either by inclusion in the text boxes provided in the survey or by separate e-mail.

Of the seven contacted participants, five took part in piloting the questionnaire. Participants included two former academics at South African higher education departments of food science and technology, one of whom was still employed in higher education in the USA at the time. The other former academic who took part in the
piloting exercise had extensive work experience within the South African food industry, as well as experience in higher education and was practising as a consultant within the field of food science and technology in the UK. The other three participants included two senior food technologists employed by an international food manufacturer based in the Middle East, and a research and development specialist employed by an international food manufacturer based in Switzerland.

Two of the participants returned comprehensive comments by e-mail, which were helpful in ensuring that the questions were constructed using simple language and not ambiguous. All the participants provided suggestions for possible refinements to the sequence and flow of the questionnaire. None of these participants commented on the length of the questionnaire, and all commented positively on the comprehensiveness of the food science and technology discipline-specific content included in the questionnaire.

3.5.4 Conducting the web-based survey

Once the questionnaire was piloted and the input received was captured to constitute the final questionnaire, the web-based survey was deployed. A purposive sampling approach was also adopted for the final data collection stage of this study to recruit the survey participants. The required population and targeted stakeholders relevant to this study, many of whom are members of the South African Association of Food Science and Technology, have been previously outlined in Table 3.4. Members of this organisation include food scientists and technologists, employers of food scientists and technologists, food and beverage manufacturers, relevant government and non-profit organisation stakeholders, and academics involved in teaching and learning about food science and technology at higher education institutions (refer to Annexure H for membership details). Thus, to ensure reliable data were collected through the web-based survey, participants were mainly identified through their membership to this organisation as this encouraged the participation of individuals with the required food science and technology expertise and experience relevant to this study (Cohen et al., 2000:103; Creswell & Plano Clarke, 2011:45).
An e-mail invitation (see Annexure G), which contained a hyperlink to participate in the survey was sent to all categories of members of the South African Association of Food Science and Technology (refer to Annexure H). However, the actual number of members who received the invitation could not be determined – only active members who had paid their yearly subscription and who had active e-mail addresses would have received the e-mail invitations. Many of the e-mailed invitations were returned as undeliverable, either due to incorrect or inactive e-mail accounts or due to the mailbox setup of the recipients implementing spamming filters (Fan & Yan, 2010:134).

A further selection criterion (Ritchie et al., 2003:78) was that participants had to have a minimum of at least one year of employment experience within the food and allied industries to participate in the survey. Therefore, filter questions that made use of skip logic (Hewson, 2015:282) were included at the start of the survey to exclude student members and new graduates with less than one year of work experience. It was assumed that student members and graduates with little or no work experience might not be knowledgeable or experienced enough to give informed responses to the survey questions. In addition, stratification (Ary et al., 2014:166, 458; Creswell, 2012:144) was introduced according to the following criteria: geographical area, employment sector, level of education, years of food science and technology experience, and the participants’ self-selected career category (namely ‘Food Scientist’, ‘Food Technologist’ or ‘Other’). Making use of stratification served the purpose of ensuring that important participant categories were included in the data collection process.

To encourage responses from the targeted population who may not be members of the South African Association of Food Science and Technology, individualised e-mail invitations containing a hyperlink to the survey were sent directly to the identified stakeholder groupings (refer to Table 3.4), including government departments and research institutions. In addition, referrals by survey participants (Ary et al., 2014:458), were followed up with e-mail invitations to the recommended participants to take part in the survey. Furthermore, to boost participation by management and organisational representatives who are suggested as less likely to respond to a survey (Baruch, 1999:421), initial invitations were followed by personalised and re-worded e-mail reminders.
Van Selm and Jankowski (2006:446) mention that in some cases participants may contact the researcher directly after receiving an introductory letter to a study or invitation to a survey, to discuss the study and sometimes to pose questions of their own to the researcher. This was indeed the case in this study where several participants contacted the researcher directly to discuss the study after having responded to the web-based survey. These interactions were experienced as valuable to the study, as additional information was obtained from the participants. In addition, these participants’ enthusiasm for the study led them to promote the survey to colleagues who may have discarded or overlooked the introductory letter and invitation.

To encourage complete responses and to obtain an acceptable response rate, the survey remained active for an extended time and reminders were sent out weekly until the live reporting of the online survey indicated a total of 290 completed survey questionnaires and no further activities to the survey. Once the collected data were cleaned, it was evident that only the data collected from 176 participants were usable due to a variety of reasons, such as not answering enough questions to provide reliable and usable data. The criteria used was that more than 85 percent of the questions should have been fully completed. Stratification based on career category, namely ‘Food Scientists’, ‘Food Technologist’, or ‘Other’, was important to ensure that the data captured showed a comparable composition in the career category to the target population; participants who had not indicated their career category were excluded from the study (Ary et al., 2014:431-3; Sauermann & Roach, 2013:285; Van Selm & Jankowski, 2006:440).

3.5.5 Validity and reliability of the web-based survey

This study adopted a quantitative research approach and made use of a questionnaire as the data collection instrument, implemented in a web-based survey. This method is proposed to be flexible, consistent, reliable and valid (Hewson, 2015:283).
3.5.5.1 Validity of the web-based survey

Validity has many dimensions and usually depends on two actions, namely the ability of the data collection instrument to collect trustworthy and ‘correct’ data, and secondly the analysis, interpretation and judgement of the data collected by the instrument (Ary et al., 2014:242; Babble & Mouton, 2001:125; Bernard, 2006:60). Furthermore, validity can be difficult to evaluate and to assist with the assessment, the general categories of internal, external, construct and statistical conclusion validity can be useful (Shadish, Cook & Campbell, 2002:33, 463). The validity of the data collection instrument developed for this study was primarily achieved by presenting content validity. Content validity is the extent to which the ‘right’ content is reflected in the data collection instrument to effectively cover the ‘construct’ of the study (Bernard, 2006:57). To confirm the content validity of the survey, a draft questionnaire was developed based on an extensive and systematic literature review identifying the key constructs (refer to Table 2.2 & 2.3) relevant to this study (Ritchie et al., 2003:270). The researcher, as a possible source of bias, was acknowledged when constructing the draft questionnaire content. To counterbalance this potential influence, a focus group consisting of prudently selected expert members was convened to enhance the content validity (Côté-Arsenault & Morrison-Beedy, 1999:280). The purpose of the focus group was for discussion and confirmation of the content, to identify omissions and delete superfluous, repetitive or unnecessary content. In addition, piloting the questionnaire before deployment was done, again to confirm the content validity of the survey (refer to 3.5.3). Piloting the questionnaire confirmed that the data required to answer the first two research sub-questions would be collected.

Furthermore, internal consistency, or how consistently the survey collected data and measured the required constructs, was achieved by restating certain constructs in different sections of the survey (Yilmaz, 2013:317). Primarily, the survey focused on collecting quantitative data which was then converted to percentages for interpretation.

The sampling approach is another important consideration when assessing the validity of a study. A non-probability sampling approach, namely purposive sampling based on the characteristics of the population and the objective of the study, was done to identify the target participants required to provide useful information and opinions.
relevant to the purpose of the web-based survey (refer to 3.4.2). An analysis of the profile of the survey participants was used to confirm that there was adequate and broad representation of the target population identified as important to the outcomes of this study.

3.5.5.2 Reliability of the web-based survey

Reliability refers to the consistency or repeatability of the data collected by the data collection instrument, and is concerned with the random errors which may result in inconsistencies (Ary et al., 2014:254; Babbie & Mouton, 2001:125). In other words, if the same survey was again conducted under similar circumstances and using the same or a similar sample, the findings would be expected to be the same (Ary et al., 2014:275; Babbie & Mouton, 2001:125).

Generally, random errors can be traced to three sources, namely the participant, the data collection instrument, or the mode of administration of the data collection instrument (Ary et al., 2014:254). A possible random error introduced by participant fatigue due to the length of the survey was to be anticipated, and several approaches were introduced to limit this effect on the reliability of collected data. These approaches included employing closed and open-ended question formats together with text boxes to break the monotony of the survey questions, making responses to all questions optional, and providing an option on each page of the web-based survey to exit the survey, skip to the next page, and/or resume the survey later.

To get reliable data, the rating scale used in the survey needed to be discrete, unambiguous and represent all possible choices (Ary et al., 2014:232; Cohen et al., 2000:253). Reliability was confirmed as the rating scale was discussed at length in the focus group discussions and it was consequently pre-tested to ensure appropriateness and to limit bias as far as possible.
3.6 DATA ANALYSIS PROCEDURES AND STATISTICAL TESTS

Statistical analysis of data collected through implementing questionnaires can range from simple to complex (Saunders et al., 2009:362). Descriptive analysis of the collected data was used to find the perceived graduate capabilities required of South African food science and technology students when they take up employment for the first time after graduating with a first qualification.

3.6.1 Web-based survey: quantitative data analysis

The quantitative data collected through conducting the survey was analysed using descriptive statistics to “present and explore” the data (Ritchie et al., 2003:289). Participants could record their opinions through a six-point Likert-type scale ranging from ‘not at all important’ to ‘extremely important’. The Statistical Package for Social Sciences (SPSS, Version 25) was used to analyse the quantitative collected data and descriptive statistics, largely based on percentages, was used to describe the data (Jamieson, 2004:1218). Comparisons were made between the information from different participant groups based on the stratification criteria included in the survey.

3.6.2 Web-based survey: additional data analysis

Additional data were collected using open-ended questions, mainly ‘Other – please specify’ questions, and comment boxes. The qualitative data were analysed by integrating “descriptive, explanatory and interpretative evidence” (Ritchie et al., 2003:289). Hsieh and Shannon (2005:1278) identify three approaches to content analysis, namely conventional, directed or summative approaches. Each of these approaches follows a similar process (Hsieh & Shannon, 2005:1285). A summative approach using keywords identified before and during the data analysis was applied in this study (Hsieh & Shannon, 2005:1285).

ATLAS.ti, used for the deductive literature review, was considered for analysing the additional data captured through the open-ended questions and comment boxes. However, the electronic format in which the additional data were collected, was not suitable to import into ATLAS.ti. and manual coding, although laborious, was used to
analyse the additional data. The additional data were coded by means of a structured and directed content analysis approach using pre-determined codes and 'in vivo' keywords (Bernard, 2006:470; Elo, Kääriäinen, Kanste, Pölkki, Utriainen & Kyngäs, 2014:6; Saldaña, 2013:6). Manual coding allowed for thematic analysis by deductively clustering similar and interrelated codes and keywords together to highlight possible valuable themes (Bernard, 2006:494; Chipchase et al., 2012:3; Gale, Heath, Cameron, Rashid & Redwood, 2013:1). The identified themes were used to a) confirm the content validity of the questionnaire and to identify possible additional constructs/ideas/data which may have been overlooked, and b) to collaborate and reinforce the quantitative findings by identifying comments which were included in the findings as direct quotations.

3.7 SYNTHESIS OF CHAPTER THREE

This chapter described the background, purpose and aims of this study. The research design and methodological choices were described and motivated, as well as the sampling measures followed, and the ethical considerations associated with this study. Once the research design was motivated, the choice of an additional data collection strategy – a survey – was presented. A focused ‘sample survey’ (Ary et al., 2014:400) was developed and administered online. The purpose of conducting the survey was to get information on the perceived needed food science and technology graduate attributes.

The process used to develop the data collection instrument for this study is summarised as follows:

- After an initial questionnaire was drafted based on a systematic literature review and according to the needs of this study, it was presented to a focus group of stakeholders identified as relevant to the study for discussion, confirmation and refinement to finalise the questionnaire content and layout.
- A finalised draft questionnaire, based on the inputs from the focus group, was converted into a web-based format and piloted with a test group of five participants.
• The web-based questionnaire was then further refined based on the inputs and comments submitted by the pilot phase participants.

• The primary quantitative data were collected by indicating perceptions on a six-point pre-determined Likert-type rating scale for the closed-ended questions in the questionnaire.

• Survey participants had the flexibility to provide additional data through comments and answers to open-ended questions (Creswell, 2012:403).

• Content-related evidence of the validity of the data collection instrument was reinforced through comparison of the findings of the quantitative data with the additional data collected through open-ended questions and comment boxes (Ary et al., 2014:251; Wahyuni, 2012:73).

Strategies to promote completion of the questionnaire were implemented to encourage higher response rates to the survey by the target population, thereby ensuring that usable data were collected. In the next chapter, the collected data will be analysed, and the findings will be described.
CHAPTER FOUR: EMPIRICAL DATA ANALYSIS AND FINDINGS

If you keep your eyes open enough, oh, the stuff you will learn! The most wonderful stuff! (Dr Suess, 1978).

4.1 INTRODUCTION AND PURPOSE

This chapter describes the analysis of the collected data to identify the required graduate capabilities of food science and technology graduates as perceived by South African stakeholders in the food science and technology industry. The analysed and interpreted data will be described following the outline shown in Figure 4.1.

Figure 4.1: Overview and structure of Chapter Four

4.2 CREDENTIALS OF THE PARTICIPANTS

To determine whether the survey participants could be considered experienced and knowledgeable enough to provide valuable and reliable information about the required food science and technology graduate capabilities, an overall profile of the participants was compiled. Once the credentials of the participants were established, the findings related to their perceptions of the required graduate capabilities of newly graduated food scientists and technologists were described.
4.2.1 Demographics and ‘credentials’ of the participants

Once the data were collected, the next step was to determine whether this group of selected respondents could be considered as knowledgeable and experienced enough to supply usable information to address the objectives of the study. The participants’ demographics and ‘credentials’ are summarised in Table 4.1.

Table 4.1: ‘Credentials’ of the selected participants

<table>
<thead>
<tr>
<th>‘Credential’ variable</th>
<th>Indicator</th>
<th>Career Category %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Food Scientist</td>
</tr>
<tr>
<td>Career Category</td>
<td></td>
<td>42,9(^1)</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>58,7</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>40,0</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>1,3</td>
</tr>
<tr>
<td>Geographical working area</td>
<td>Gauteng</td>
<td>56,6</td>
</tr>
<tr>
<td></td>
<td>Western Cape</td>
<td>25,7</td>
</tr>
<tr>
<td></td>
<td>Other seven provinces</td>
<td>14,3</td>
</tr>
<tr>
<td></td>
<td>Outside SA</td>
<td>3,4</td>
</tr>
<tr>
<td>Formal Education</td>
<td>No higher education qualification</td>
<td>3,9</td>
</tr>
<tr>
<td></td>
<td>Food science and technology qualification/s</td>
<td>44,7</td>
</tr>
<tr>
<td></td>
<td>Food science and technology qualification + other higher education qualification</td>
<td>38,2</td>
</tr>
<tr>
<td></td>
<td>No food science and technology qualification, but other higher education qualification</td>
<td>13,2</td>
</tr>
<tr>
<td>Employment status</td>
<td>Not employed/retired</td>
<td>7,0</td>
</tr>
<tr>
<td></td>
<td>Employed in food, beverage and allied industries</td>
<td>50,7</td>
</tr>
<tr>
<td></td>
<td>Employer of food scientists and technologists</td>
<td>4,2</td>
</tr>
<tr>
<td></td>
<td>Employed other than food industry</td>
<td>0,0</td>
</tr>
<tr>
<td>‘Credential’ variable</td>
<td>Indicator</td>
<td>Food Scientist</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>Employed in higher education</td>
<td>19,7</td>
</tr>
<tr>
<td></td>
<td>Employed in government or the public sector</td>
<td>5,6</td>
</tr>
<tr>
<td></td>
<td>Self-employed/Not formally employed</td>
<td>12,7</td>
</tr>
<tr>
<td>Work Experience</td>
<td>No experience</td>
<td>4,0</td>
</tr>
<tr>
<td></td>
<td>Newly graduated, or employed for less than one year</td>
<td>12,0</td>
</tr>
<tr>
<td></td>
<td>Between 1 and 10 years</td>
<td>36,0</td>
</tr>
<tr>
<td></td>
<td>Employed ≥ 11 years</td>
<td>48,0</td>
</tr>
</tbody>
</table>

The following was highlighted in Table 4.1:

- Participants were from all three career categories – ‘Food Scientist’, ‘Food Technologist’ and ‘Other’. The ‘Other’ career category included participants who did not identify with being a food scientist or a food technologist, but who were active in the food, beverage and allied industries.
- An inclusion of both genders, with females in the majority, was observed.
- The broad distribution of participants by geographical location was proved, with the two provinces most economically viable in the food and allied sector dominating.
- The diversity of stakeholder groupings named as important to this study was shown.
- Most participants had formal higher education qualifications in food science and/or food technology, or in a discipline relevant to the food and allied sector.
- More than half of ‘All’ participants had 11 years or more relevant work experience within the food, beverage and allied industries environment.

It was also necessary to see whether the responses collected in terms of employment represent the different commodity categories of the food, beverage and allied industries – such as dairy, meat, cereals, grains and baked goods (Annexure F, item 1.8 and section 5). These different commodity categories required more specialised food science and technology knowledge, skills and competencies and could possibly
have had different graduate capability entry requirements (Harcourt, 2011:6; Ho et al., 2011:9-11). For example, basic food safety knowledge is common to all food and related sectors, but the food safety knowledge needed to ensure legislative compliance and to conduct informed risk analysis varies between different food and beverage products (Lammerding & Fazil, 2000:148; Yapp & Fairman, 2006:45). The outcomes of the question probing this information showed that there was a wide-ranging representation of employment experiences in the commodity sectors within the food, beverage and related industries, and that all commodity areas were represented (refer to Annexures I & J). Therefore, the diversity of employment experience across different sectors of food, beverage and allied industries was established.

The participants’ profile confirmed they were appropriately experienced and knowledgeable to meaningfully contribute to the objectives of the study. Further analyses of the participant profile of each of the three career categories showed that more than half (53.6%) of the ‘Other’ career category participants did not have the higher education qualifications required to provide an informed opinion on the discipline-specific fundamental and sector-specific knowledge, skills and competencies required of food scientists and technologists. Their expertise may have been limited to only some items in the sections of the survey dealing with food science and food technology knowledge, skills and competencies. Linked to the small number of participants in this career category (n=29), it was decided to exclude their responses from data analyses for the food science and food technology discipline-specific sections of the survey. Nevertheless, based on the employment profile of the ‘Other’ career category, their input was relevant and valuable to the sections probing the generic graduate attributes and personal attributes of food science and technology graduates when taking up employment.

4.2.2 Summarising the participant profile

To summarise, one can conclude that the participants were credible and able to supply valid information on the graduate capabilities required of food science and technology graduates when they take up employment for the first time. Therefore, in the following
sections an analysis of the data will be done, and the outcomes will be described in terms of perceived required graduate capabilities.

4.3 DIFFERENTIATION BETWEEN FOOD SCIENTISTS AND FOOD TECHNOLOGISTS

Scrutiny of the definitions of food science and food technology, and of food scientists and food technologists, suggests that although food technology is defined as the application of food science, in practice there is little differentiation between the terms and they are often used interchangeably (Floros et al., 2010:572; IFST, 2017:1; IFT, 2011:4; Kostaropoulos, 2012:111; Potter & Hotchkiss, 1998:1; refer to 1.3.2). It seems that this is also true within the South African practical context where there is little to differentiate a food scientist from a food technologist within the workplace. The only noticeable ‘difference’ in the South African context is that food science programmes are offered by traditional academic universities, while food technology programmes are career-focused vocational education and are offered by vocationally-focused academic institutions. Based on this distinction, and to determine if food science and food technology are separate areas of education within the South African context, the survey participants were asked to give free-response comments differentiating between food scientists and food technologists within the workplace. The responses to these open-ended questions by the ‘Food Scientist’, Food Technologist’ and ‘Other’ career category participants were then analysed separately.

A summary of the findings (see Annexure K) shows that ‘Food Scientist’ participants view food scientists as having a stronger scientific academic focus than food technologists during their higher education studies. The findings also indicated that food scientists are perceived to be more suitable for conducting research and being involved with research and development within the discipline of food science and technology than food technologists. Similarly, the ‘Food Technologist’ participants concurred that food scientists should have a stronger academic focus – including scientific and disciplinary knowledge – than the food technologists, and they are mainly prepared for roles in research, and research and development. In comparison, both the ‘Food Science’ and Food Technologist’ participants perceived food technologists as more practical and able to apply food science and technology knowledge to real-
world situations. Content analysis of the comments received from the ‘Other’ career category reiterated that this career category also viewed food scientists as having an advanced scientific grounding with a more academic focus than food technologists, thus making them more suitable for a research environment. In contrast, food technologists were suggested by the ‘Other’ group to be more practically oriented and have the capability to apply food science and technology disciplinary knowledge in different contexts.

These findings thus indicated that within the South African context, food science and food technology are strongly associated and seemingly difficult to separate. The participants to this survey did voice the opinion that the differentiation between a food scientist and a food technologist is not always applicable or practical within the workplace where food scientists and food technologists are expected to work side-by-side, perform similar functions, and have similar foundational knowledge, skills and competencies. Therefore, within the context of this study, it is assumed that the graduate capabilities required to ‘become’ a South African food scientist or food technologist are fundamentally the same. This finding is corroborated by the view of Chen and Stroup (1993:447), who state that science and technology are moving closer to each other, rather than remaining two distinct ways of “knowing”. However, to confirm this assumption, the data related to the generic graduate and personal attributes collected through the survey will be analysed and presented per career category group of ‘Food Scientist’, ‘Food Technologists’, ‘Other’ and ‘All’ participants to identify agreement and differences. The data collected regarding the food science and technology-specific knowledge, skills and competencies will also be analysed and presented separately for the ‘Food Scientist’ and ‘Food Technologist’ career categories before being compared. Based on these findings, a conclusion will be drawn whether different or similar graduate capabilities are required from food scientists versus those required from food technologists.
4.4 SURVEY DATA ANALYSIS TO IDENTIFY THE REQUIRED GRADUATE CAPABILITIES

4.4.1 Introduction to the survey data analysis methods and criteria

Quantitative survey responses were collected using a six-point Likert-type response category scale (refer to 3.3.4.2 & Table 3.3). For the quantitative data analysis, each response category was linked to a specific and unique numerical value which was not visible to the participants, namely: One (1) corresponded with ‘not at all important’ and six (6) with ‘extremely important’ (refer to Table 4.2). The quantitative collected data were analysed by applying the SPSS Version 25.

To simplify the analysis of the obtained responses, the six response categories were re-coded to only three response categories, as shown in Table 4.2.

Table 4.2: Rating scale and data analysis categories

<table>
<thead>
<tr>
<th>Rating scale statements provided on online survey</th>
<th>Data analysis importance classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not at all important</td>
<td>A. Low importance</td>
</tr>
<tr>
<td>2. Low importance</td>
<td></td>
</tr>
<tr>
<td>3. Slight importance</td>
<td>B. Moderate importance</td>
</tr>
<tr>
<td>4. Moderately important</td>
<td></td>
</tr>
<tr>
<td>5. Very important</td>
<td>C. High importance</td>
</tr>
<tr>
<td>6. Extremely important</td>
<td></td>
</tr>
</tbody>
</table>

In conducting the descriptive analysis of the responses, it was decided to calculate the percentage of responses that would give an indication of the importance attached to each attribute, skill and competency and the fundamental food science and technology discipline-specific knowledge. Capabilities indicated as being of ‘high importance’ were used in the further discussions.

For analysis purposes, ‘high importance’ is the combination of the ‘very important’ and ‘extremely important’ response categories (refer to Table 4.2). In this study, a required graduate capability is indicated by 80 percent or more ‘high importance’ responses, which is a criterion in line with existing literature (Chipchase et al., 2012:1; Johnston et al., 2014:14; Saunders & Zuzel, 2010:Analysis of data, para 3). Percentage
responses were calculated based on the number of responses received and did not rely on 100 percent response rate. One should keep in mind that this study aimed to find graduate capabilities which are **expected** and **required** of food scientists and technologists when they graduate with a first degree, rather than to identify attributes and skills which are considered of moderate or of low importance.

Provision was also made for comments to ‘Other – please specify’ questions at the end of each subsection of the survey to allow participants to record any additional skills that they perceived as important and which were not adequately captured in the provided survey skill statements. In addition, a comment box was provided so that additional general comments about each section could be captured. Apart from collecting more and collaborating data, free-response questions and comments allowed participants to record their own opinions and to be more engaged with the study (Cohen et al., 2005:255). The open-ended responses were first analysed through manual content analysis using pre-determined codes and highlighting ‘in vivo’ keywords that represented additional skills (Elo et al., 2014:6; Hsieh & Shannon, 2005:1285; Saldaña, 2015:6). This was followed by grouping/clustering similar and interrelated codes or keywords together and then deductively analysing the resulting themes (Chipchase et al., 2012:3; Gale et al., 2013:1). Corroborating evidence was found for the quantitative findings of the survey, and additional graduate capabilities that may not have been adequately captured by the survey content were identified.

### 4.4.2 Analysis: Generic graduate attributes

The identified generic transferable skills or ‘graduate attributes’ (refer to Annexure F, Section 2, items 2.1 – 2.4) that will be investigated and described in this section were grouped into subsections as they appeared in the finalised survey questionnaire, namely:

- General employability skills
- General communication skills (written and verbal)
- Leadership and management skills
- Diversity management skills
4.3.2.1 General employability skills

The responses to the questions on general employability skills included in the questionnaire were analysed using the percentage of responses to each importance category. Figure 4.2 depicts the percentage of ‘high importance’ responses to the general employability skill statements (see Annexure F, items 2.1.1 – 2.1.5).

![Figure 4.2: General employability skills perceived as of 'high importance'](image)

When looking at the responses of ‘All’ participants, that is the combined ‘Food Scientist’, ‘Food Technologist’ and ‘Other’ career categories, Figure 4.2 shows that all the listed general employability skills were perceived to be of ‘high importance’, and therefore required of newly graduated food science and technology professionals. When comparing the percentage ‘high importance’ responses per career category, only the ‘Other’ career category did not perceive ‘information retrieval’ to be an essential skill in terms of the criteria used for this study. However, digital skills will become increasingly critical to employability in the future (Spires et al., 2018:2235; Van Laar et al., 2017:577) and are essential for life-long learning (Coetzee, 2014:490; Easa, 2013:552). Therefore, computer literacy and information technology (see Figure 4.2, question 3 & 4) were clustered as digital technical skills and digital
literacy, and were identified as a potential area for improvement within existing food science and technology programmes.

a) Influence of years of work experience

Over half of the participants (57.8%) had eleven or more years of work experience, with newly employed participants being a smaller group (see Table 4.1). Filter questions were included at the start of the survey to exclude students and new graduates with less than one year of work experience from participating. Despite this, 11 percent of the survey participants indicated no work experience (2.3%) or less than one year of work experience (8.7%). The possibility exists that newly graduated and more work-experienced participants may have placed different emphasis on the importance of employability skills. Therefore, to determine the possible influence exerted by participants’ years of work experience on their perception of required skills/capabilities, survey participants were categorised into three work-experience groups, namely:

- Group 1: No experience to little experience (less than one year) (11.0% of participants)
- Group 2: One to ten years of work experience (31.2% of participants)
- Group 3: More than 11 years of work experience (57.8% of participants)

Figure 4.3 presents the findings based on the categorisation of the participants into the three groupings according to years of work experience. The outcomes show that all groups rated the skills investigated of ‘high importance’, and participants’ work experience does not result in a different perception of which general employability skills are essential. This finding supported the findings of Saunders and Zuzel (2010: Discussion, para. 3), and Andrews and Higson (2008:420) that there is little difference between the priorities of recent graduates and employers with greater work experience when rating the importance of skills. The possible influence of years of work experience as an influential factor was therefore excluded from further data analysis and the data collected from Group One participants was included in the analysis.
b) Additional general employability skills

The participants were requested to provide additional employability skills that they perceived as important and that were not sufficiently captured in the questionnaire items. The responses were manually coded using content analysis followed by thematic framework analysis to group comparable and interconnected codes and keywords together (Chipchase et al., 2012:3). Skills and attributes interrogated elsewhere in the survey were then excluded or, if the comments were considered valuable, they were linked to the applicable section in the survey where the skill or attribute was better captured. This process did not identify any additional general employability skills that were not already included in the survey.
c) Summary of the findings: General employability skills

Based on the responses of ‘All’ participants, all the general employability skills and capabilities surveyed may be perceived as required of food science and food technology graduates.

The influence of participants’ years of work experience on the perceived high importance of general employability skills was minor. Regardless of years of work experience, participants perceived all the skills as being of ‘high importance’ (refer to Figure 4.3). Based on these findings, further data analysis based on the criteria of participants’ years of work experience was excluded from data analysis of the later sections of the survey.

4.4.2.2 Communication skills

The ability to properly and effectively communicate is considered an essential generic transferable skill and is sometimes even identified as more important than discipline-specific knowledge, skills and competencies in the modern workplace (Adam, 2009:174; Adayemo et al., 2010:104; Allais, 2017:156; Hitchliffe & Jolly, 2011:570). In this section, the purpose is to firstly identify which official language/s is preferred in the South African workplace, followed by two further subsections, namely an analysis of verbal and written communication skills.

a) Languages of communication

The participants were asked to select from a list of all eleven South African official languages the most important language/s in which communication is required when newly graduated food scientists and technologists enter the workplace for the first time. The findings are represented in Figure 4.4 and clearly shows that English is the dominant language in which workplace communication skills is required, followed by Afrikaans, isiZulu, isiXhosa, Sesotho and Setswana.
Participants could select more than one language

Figure 4.4: Most important language/s in which communication is required
English as the main language in which communication skills are needed from food science and technology graduates was corroborated by Adam (2009:219) who suggests that English is the global language of “business and communication”. The finding of this study confirmed that institutions of higher learning must ensure their graduates, also in food science and technology as the focus of this study, are well versed in English as the medium of workplace communication.

b) General written communication skills

Participants were requested to rate the importance of general written communication skills that were identified when developing the questionnaire (refer to Table 2.3). The percentage of ‘high importance’ responses to the survey statements (see Appendix F, item 2.2.1) from all the participants, as well as per career category, are presented in Figure 4.5.

![Figure 4.5: General written communication skills](image)

Based on the defined criteria of ‘high importance’ responses from ‘All’ participants, all the skills listed in the survey were identified as required graduate capabilities.
The importance of using e-mails effectively and e-mail etiquette was reaffirmed in responses to the open-ended question at the end of the section, with direct statements such as “e-mail etiquette and ensuring that appropriate stakeholders or recipients are communicated to” [Food Scientist] and the “use of SMS type language abbreviations in formal communication, including e-mails, is unacceptable” [Food Scientist].

c) Verbal communication skills

To analyse the perceived verbal communication skills required of food science and technology graduates, participants were asked to rate the importance of the skills included in the survey (see Annexure F, item 2.2.2). The outcomes of the findings are presented in Figure 4.6:

![Verbal communication skills](chart.png)

**Figure 4.6: Verbal communication skills**

Based on the ‘High Importance’ requirement, ‘All’ participants identified the required skills as being:
1. **listening skills** through **responding** in a manner that shows understanding of what has been said;
2. using the **appropriate level of verbal communication** to the listener and situation, including communicating technical information to a non-technical audience; and
3. **clear, confident and effective oral communication** to an individual or group in both formal and informal situations.

The importance of listening skills was further highlighted by the open-ended responses received from participants, which included: “Listening. I found the first question posed to me is ‘Sorry’?” [Food Technologist] and “A new graduate’s knowledge is very shallow in any branch of the industry, so listening and learning is vital” [Food Scientist].

‘Demonstrating professional telephone etiquette’ and ‘sensitivity to factors such as political, cultural, disability and gender issues when verbally communicating with an individual or group’ were perceived by ‘All’ the participants as skills not required of new graduates in terms of the criteria used for this study. However, a response from a Food Technologist to the open-ended question at the end of the section highlighted the importance of sensitivity by stating that “communication skills should display a degree of courtesy and etiquette”. Therefore, it follows that although ‘sensitivity when communicating to an individual or a group’ is not named as a required capability in terms of the criteria used for this study, it is expected that new graduates will have this skill to a certain extent.

d) **Summary of the findings: Communication skills**

The findings showed that English proficiency is an essential graduate capability, since English is the main medium of communication in the workplace (see Figure 4.4). However, English is not usually the first language of communication among students entering South African higher education institutions (Nel & Müller, 2010:635). All the written communication skills included in the survey were identified as required skills for food science and technology graduates (refer to Figure 4.5 & Appendix F, item 2.2.1). The importance of ‘effective e-mail communication’ was not a surprising finding, as it is reported to be second only to face-to-face communication within the workplace (Lim & Chin, 2006:1247). E-mail correspondence is the preferred method of
communication of women, who made up the larger percentage of survey participants in this study (Kimbrough, Guadagno, Muscanell & Dill, 2013:898). Furthermore, impoliteness in electronic communication has been reported to have a potentially negative impact within the workplace, and civility in this form of communication is becoming increasingly important (Giumetti, Hatfield, Scisco, Schroeder, Muth & Kowalski, 2013:297; Lim & Chin, 2006:1247).

When considering verbal communication skills, the following itemised skills included in the survey (refer to Appendix 4, item 2.2.2) were identified as essential in terms of the criteria adopted for the study: a) listening skills, b) using a level of communication appropriate to the situation, and c) the ability to communicate clearly, confidently and effectively.

4.4.2.3 Leadership and management skills

General business management skills have been reported to become more important to the employability of graduates (Jack et al., 2012:14). Based on this assumption, those leadership and business skills that can be developed and enhanced by higher education were identified through literature (refer to Table 2.3) and included in the survey (see Annexure F, item 2.3).

The outcomes of the analysis identified the following leadership and management skills required from food science and technology graduates (Figure 4.7):
Figure 4.7: Leadership and management skills: Indication of ‘high importance’ – All participants
Based on the findings presented in Figure 4.7, the following were identified as being of ‘high importance’:

- Effective **time management** and **meeting deadlines** (time- and self-management skills).
- **Working efficiently** with a high level of effort and in a structured manner (time- and self-management skills).
- **Self-management** and the ability to **multi-task**.
- **Critical thinking** to deconstruct a problem or situation and then develop solutions to solve the problem.
- **Prioritising, setting goals** and **planning** a structured course of action to achieve goals by ranking tasks according to importance (time- and self-management skills).
- **Problem-solving**: Include the naming of problems; creating, identifying and implementing solutions to correct a problem; and, evaluating the effectiveness of the solution/s with a view to implement further improvements.
- **Decision-making skills**: Including generating and weighing up different alternatives, finding the best way to achieve the desired goal, and implementing the decision.
- **Managing work pressures** effectively (time- and self-management skills).
- **Teamwork**: Including the ability to work constructively as a team member.
- **Adaptability and flexibility** to respond to changing circumstances and new challenges.
- **Project planning and scheduling** and the ability to **delegate** tasks to meet a goal (time- and self-management skills).

**Entrepreneurial skills** received the lowest percentage of ‘high importance’ responses for all the skill items listed in this subsection of the survey (refer to Figure 4.7). This finding may possibly be explained by the employment status of ‘All’ participants (refer to Table 4.1), which indicates that over 50 percent are employed in the food or allied industry. Entrepreneurial skills may be perceived by these participants as useful only for graduates who plan to set up their own business. Furthermore, employers may view graduates exhibiting entrepreneurial traits, which is about more than skills and includes personal characteristics such as risk-taking, as unable to conform to the
needs of ‘formal’ employment (Sewell & Pool, 2010:92-93). However, within the South African context, there is a shortage of entrepreneurial skills (SA DAFF, 2012:136), and higher education institutions are encouraged to “shift and train for entrepreneurial existence” (SA DHET, 2013:122). The ‘ChaANGe framework’ (Maxwell & Armellini, 2019:76) of graduate attributes recognises the importance of entrepreneurship as a necessary generic graduate attribute. Therefore, it is suggested that entrepreneurial skills must be considered as a graduate capability required of food science and technology graduates. Sewell and Pool (2010:93) suggest that this can be achieved by embedding entrepreneurial activities within the curriculum where possible.

Further analysis of the findings showed overlap between the three capabilities with the highest percentages of ‘high importance’ responses, namely 1) time management (refer to Figure 4.7, question 8), 2) working efficiently (refer to Figure 4.7, question 7), and 3) self-management (Figure 4.7, question 5), since ‘working efficiently in a structured manner’ is dependent on good time-management skills and self-management. In fact, further examination of the outcomes highlighted that five of the leadership and management skills researched in the questionnaire could reasonably be clustered together to form ‘Time- and self-management skills’ (refer to Table 4.3), seeing that it is unlikely to demonstrate one without implicating the others.

Table 4.3: Time- and self-management skills: Result of clustering overlapping and related skills and capabilities

<table>
<thead>
<tr>
<th>Perceived level of ‘high importance’: Time- and self-management skills</th>
<th>Career Category</th>
<th>‘All’</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
<th>‘Other’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% High NB responses</td>
<td>% High NB responses</td>
<td>% High NB responses</td>
<td>% High NB responses</td>
<td></td>
</tr>
<tr>
<td>Q8: Time management &amp; meeting deadlines</td>
<td>97,7</td>
<td>97,4</td>
<td>97,2</td>
<td>100,0</td>
<td></td>
</tr>
<tr>
<td>Q7: Working efficiently with effort</td>
<td>96,0</td>
<td>94,7</td>
<td>95,8</td>
<td>100,0</td>
<td></td>
</tr>
<tr>
<td>Q5: Self-management &amp; ability to multi-task</td>
<td>92,6</td>
<td>94,7</td>
<td>87,3</td>
<td>100,0</td>
<td></td>
</tr>
<tr>
<td>Q6: Prioritising, setting goals &amp; planning</td>
<td>91,5</td>
<td>89,3</td>
<td>91,7</td>
<td>96,6</td>
<td></td>
</tr>
<tr>
<td>Q19: Managing work pressures</td>
<td>88,1</td>
<td>92,1</td>
<td>86,1</td>
<td>82,8</td>
<td></td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance
Project planning, scheduling and delegating were not incorporated into the time- and self-management skills cluster, as these skills were viewed as a more specific skill requirement related to project management.

Based on the results of clustering leadership and management skills (see Table 4.3), the ‘high importance’ leadership and management skills are shown in Table 4.4.

**Table 4.4: Clustered leadership and management skills: Perceived ‘high importance’**

<table>
<thead>
<tr>
<th>Perceived level of ‘high importance’: Leadership and management skills</th>
<th>Career Category</th>
<th>‘All’</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
<th>‘Other’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% High NB responses</td>
<td>% High NB responses</td>
<td>% High NB responses</td>
<td>% High NB responses</td>
</tr>
<tr>
<td>Q5, 6, 7, 8 &amp; 19: Time- &amp; self-management skills</td>
<td>93,2</td>
<td>93,6</td>
<td>91,6</td>
<td>95,9</td>
<td></td>
</tr>
<tr>
<td>Q12: Critical thinking skills</td>
<td>91,9</td>
<td>91,9</td>
<td>91,3</td>
<td>93,1</td>
<td></td>
</tr>
<tr>
<td>Q17: Problem-solving skills</td>
<td>91,5</td>
<td>90,8</td>
<td>95,8</td>
<td>82,8</td>
<td></td>
</tr>
<tr>
<td>Q9: Decision-making skills</td>
<td>88,1</td>
<td>89,5</td>
<td>86,1</td>
<td>89,7</td>
<td></td>
</tr>
<tr>
<td>Q1: Teamwork</td>
<td>87,5</td>
<td>85,5</td>
<td>90,3</td>
<td>86,2</td>
<td></td>
</tr>
<tr>
<td>Q16: Adaptability &amp; flexibility</td>
<td>84,2</td>
<td>85,5</td>
<td>86,1</td>
<td>75,9</td>
<td></td>
</tr>
<tr>
<td>Q13: Project planning &amp; delegating</td>
<td>84,1</td>
<td>85,3</td>
<td>84,7</td>
<td>79,3</td>
<td></td>
</tr>
<tr>
<td>Q14: Commercial awareness</td>
<td>79,7</td>
<td>77,6</td>
<td>81,9</td>
<td>79,3</td>
<td></td>
</tr>
<tr>
<td>Q11: Presenting facts</td>
<td>78,0</td>
<td>68,4</td>
<td>83,3</td>
<td>89,7</td>
<td></td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance

The **time- and self-management** skills cluster is perceived to include required graduate capabilities. The same applies for **critical thinking** skills; **problem-solving** skills; **decision-making** skills; **teamwork**; **adaptability and flexibility**; and **project management skills and the ability to delegate**. Critical thinking skills, in addition to being essential to food scientists and technologists, are also regarded as “a fundamental educational ideal” and involves the ability to reason (Siegel, 2010:141) and the motivation to think and become ‘active learners’ (Purpura, 2008:3). Critical thinking contrasts from analytical thinking in that it allows an opinion to be formed which is not only based on facts and information, while analytical thinking results in a logical conclusion through a systematic and focused process of thinking based on
information and facts (Purpura, 2008:3; Siegel, 2010:141). Both critical and analytical thinking skills impact on problem-solving and decision-making skills, and it is therefore not surprising that the participants perceived all three of these skills as essential for food science and technology graduates to be effective in the workplace.

The general written comments supported the importance of some of the leadership and management skills provided in this subsection of the survey. One participant observed that the “ability to adapt one’s style to cater for different situations and different people” [Food Scientist] was important. Another participant specified the importance of “good EQ [emotional quotient] and cross functional working ability” [Other]. Other open-ended responses supporting skill items analysed in the survey included the importance of “behavioural skills, project management skills and time management skills” [Food Technologist]. Another participant identified “problem-solving, prioritising / time management” [Food Technologist] as important. The nature of leadership was acknowledged by one respondent who stated that “leadership by in [sic] large comes naturally… or not. However, good skills can be learnt to support great leadership capabilities” [Other].

The importance of the personal attributes required to underpin leadership and management skills was captured by a participant who identified the following necessary attributes: “Assertiveness – Stakeholder management – Managing for results – ability to enable results through others – Ability to energise and engage effectively” [Food Technologist].

The notion that leadership skills are not essential on first taking up employment, and that these skills can be developed during employment, was stated by a participant who wrote: “Dependent on the level of operation; Senior management positions will require more skills but at lower levels [newly graduated] employee [sic] can rely on this to be handled by a Superior” [Food Technologist].

In general, the open-ended responses supported generic transferable leadership skills that can be learned, rather than those associated with the inherent personality and leadership qualities of the graduate.
a) Summary of the findings: Leadership and management skills

The required leadership and management skills identified by ‘All’ participants show that those graduate capabilities related to time- and self-management skills were viewed as being of greater importance than those related to leadership skills and qualities. This outcome is supported through the general open-ended responses received at the end of the subsection which suggested that leadership skills are not essential to graduating and can be developed during employment.

Effective time management, and meeting deadlines, working efficiently with an elevated level of effort and in a structured manner, and self-management and the ability to multi-task, are perceived as the most important management skills by ‘All’ participants (see Figure 4.7). The aforementioned skills can be clustered together with ‘prioritising’, ‘setting goals’ and ‘planning’ a structured course of action to achieve goals, by ranking tasks according to perceived importance’ and effectively ‘managing work pressures’ to form a cluster of ‘time- and self-management skills’.

The essential leadership and management skills perceived as being required of newly graduated food scientists and technologists should be integrated into the curriculum and enhanced during undergraduate studies through effective teaching and learning strategies and assessment practices.

4.4.2.4 Diversity management skills

Diversity in the workplace is complex and multifaceted and mainly deals with differences between people in terms of race, gender, sexual orientation, religion, political views, ethnicity, level of education, social class, age, work and life experiences, and disability, to name a few (Patrick & Kumar, 2012:1; Wambui et al., 2013:203). Based on the assumption that the South African workplace is demographically diverse, and diversity management skills may be essential to the effective functioning of a food scientists and technologists in the workplace (Martin, 2014:89; Mazibuko & Govender, 2017:Abstract), the next subsection probed some diversity management skills identified through literature (see Appendix F, item 2.4).
Figure 4.8 summarises the perceived importance of diversity management as a required graduate capability.

![Diversity Management Skills](image)

**Figure 4.8: Diversity management skills: Comparison of ‘high importance’ responses (%)**

The results depicted in Figure 4.8 show that none of the diversity skills is perceived as essential to food scientists and technologists in terms of the criteria adopted for this study. Comments to the open-ended question at the end of the subsection corroborated these findings with one participant observing that “the above mentioned [diversity skills] are important, but in relation to a person’s scientific and organisational skills, I find these less important” [Food Scientist].

‘Political sensitivity’ received the lowest ‘high importance’ responses of all the items provided in the survey on diversity management. In a sense, this was a ‘surprising’ finding considering the highly charged political arena in South Africa presently. In supporting this finding, one of the participants wrote “I think we need to ‘get over’ the diversity issue, just treat others as equals without having to consciously manage this” [Food Technologist].
a) Summary of findings: Diversity management skills

Diversity management skills as potential required skills of new food science and technology graduates were included as a separate subsection of the generic transferable employability skills. The findings showed that although these skills are not viewed as unimportant graduate capabilities, diversity management skills are not perceived as essential skills to enter the food science and technology profession. This finding was corroborated through the general comments at the end of the diversity management skills subsection.

Griesel and Parker (2009:18) suggest that higher education in South Africa does expose students to diverse cultures which prepares them for a great deal of cultural diversity in terms of employment in South Africa and global mobility. The findings may also suggest that diversity management skills, rather than being required of a graduate when first taking up employment, can/will be developed through work experience and workplace training initiatives to meet the requirements of the organisation once graduates enter employment. This idea is supported by some authors who propose that diversity management skills, rather than being an outcome of higher education, should be developed through organisational culture and training initiatives to meet the requirements of organisations during employment (Chrobot-Mason & Aramovich, 2013:660; Patrick & Kumar, 2012:1). Despite the findings of the survey, employers may reasonably expect that food science and technology graduates demonstrate basic diversity management skills when they first take up employment and it is suggested that basic diversity management skills learning outcomes should be included in food science and technology programmes.

4.4.2.5 Summary of findings: Generic graduate attributes

The aim of this section of the survey was to identify the generic graduate attributes and associated employability skills and characteristics of graduateness as perceived required graduate capabilities (refer to Figure 1.2) of newly graduated South African food science and technology professionals upon entering the workplace. In Table 4.5 the findings are summarised. It follows that these generic graduate attributes should
be developed and enhanced during food science and technology graduates' time of study.

Table 4.5: Summary of the essential generic graduate attributes identified by ‘All’ participants

<table>
<thead>
<tr>
<th>Generic graduate attributes subsections</th>
<th>Identified essential generic graduate attributes</th>
</tr>
</thead>
</table>
| General employability skills (refer to Table 4.2) | Q1: Reading skills  
Q2: Numeracy and mathematical skills  
Q3: Computer literacy skills  
Q4: Information retrieval skills  
Q5: Organisational skills |
| Communication skills (refer to Figures 4.5 & 4.6) | English as the language of communication  
Q1-6: Written communication skills  
Q1, 2 & 4: Verbal communication skills |
| Leadership and management skills (refer to Figure 4.7 & Table 4.4) | Q 5, 6, 7, 8 & 19: Time and self-management skills  
Q12: Critical thinking skills  
Q17: Problem-solving skills  
Q9: Decision-making skills  
Q1: Teamwork  
Q16: Adaptability and flexibility  
Q13: Project planning skills |
| Diversity management skills (refer to Figure 4.8) | Q1-4: All found to be non-essential |

4.4.3 Personal attributes

Based on the assumption that personality attributes, including attitudes, qualities and characteristics are important to the employability of graduates in general, and recognising that more specific personal attributes, including personal values, may be required of food science and technology graduates, personal attributes were included in the survey as a separate section (refer to Annexure F, Section 3, Items 3.1 to 3.26). The personal attributes that were researched in this study included:

- Personal qualities
- Dispositions and values
- Self-management skills
- Skills associated with emotional intelligence
- Intellectual skills and behaviours

Participants were asked to rate the perceived importance of each of the presented personal attributes, which were then listed from the highest to the lowest importance for the total group of participants ('All' participants) in Table 4.6.

Table 4.6: Personal attributes percentage ‘high importance’ response for ‘All’ participants

<table>
<thead>
<tr>
<th>Personal attributes</th>
<th>‘All’ (% high importance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q24: Pay attention to detail and like to do things properly.</td>
<td>97.2</td>
</tr>
<tr>
<td>Q23: Accountable and responsible, including the ability to admit to mistakes and accept and carry out instructions in a constructive manner.</td>
<td>95.5</td>
</tr>
<tr>
<td>Q5: Self-motivated and demonstrate initiative.</td>
<td>92.7</td>
</tr>
<tr>
<td>Q14: Common-sense and logical approach to society and the workplace including the ability to analyse/solve problems and reflect on and evaluate situations and own performance.</td>
<td>92.7</td>
</tr>
<tr>
<td>Q15: Professionalism including presenting a positive personal image.</td>
<td>92.7</td>
</tr>
<tr>
<td>Q13: Intellectual curiosity, eagerness to learn and commitment to ongoing learning to meet the needs of employment and life, including the ability to identify opportunities for life-long learning, and to learn new skills as required by the workplace.</td>
<td>91.5</td>
</tr>
<tr>
<td>Q1: Positive attitude and belief that capabilities (e.g. intelligence and attitudes) can be continually developed.</td>
<td>90.4</td>
</tr>
<tr>
<td>Q2: Perseverance, resilience and adaptable to changing situations.</td>
<td>90.4</td>
</tr>
<tr>
<td>Q8: Display high energy with a ‘can do’ approach, take on tasks, set goals and continually enhance work performance level.</td>
<td>89.3</td>
</tr>
<tr>
<td>Q12: Manage stress through demonstrating the ability to retain effectiveness under pressure.</td>
<td>87.6</td>
</tr>
<tr>
<td>Q11: Accept criticism without retaliating negatively.</td>
<td>84.7</td>
</tr>
<tr>
<td>Q18: Ethical sensitivity and integrity, including trustworthiness and behaving honestly and fairly, making positive use of rules and/or values and exhibiting good work ethics.</td>
<td>84.7</td>
</tr>
<tr>
<td>Q6: Work independently with little supervision.</td>
<td>83.3</td>
</tr>
<tr>
<td>Q4: Confidence in dealing with challenges in an assertive, firm and positive manner.</td>
<td>83.1</td>
</tr>
<tr>
<td>Q3: Self-aware of own strengths, weaknesses, aims and values.</td>
<td>80.8</td>
</tr>
<tr>
<td>Q22: Creativity and the ability to be original, inventive and to apply lateral thinking.</td>
<td>80.6</td>
</tr>
<tr>
<td>Q20: The resolve to take risks, accept challenges and speak up in demanding situations.</td>
<td>78.0</td>
</tr>
<tr>
<td>Q7: Take action and/or informed risks without prompting when dealing with challenges.</td>
<td>76.3</td>
</tr>
<tr>
<td>Q17: Occupational awareness, including nurturing the company culture and enthusiasm for food science and technology.</td>
<td>73.4</td>
</tr>
<tr>
<td>Q21: Ambition to better one’s own circumstances.</td>
<td>72.2</td>
</tr>
</tbody>
</table>
Most of the personal attribute statements provided in the survey were perceived to be of ‘high importance’ by ‘All’ participants, with the ability to ‘pay attention to detail and like to do things properly’ receiving the highest (97.2%) importance score. This finding was reaffirmed through comments provided by participants at the end of the section probing personal attributes, which included “attention to detail is very important” [Food Technologist].

‘Likeability’ was perceived as not being of ‘high importance’ by the participants in terms of the criteria used for this study. This sentiment was corroborated by one of the participants who commented:

I would rather take people who are less ‘LIKEABLE’ and more able to ‘DELIVER THE RESULTS’. I’ll be honest, most of the most successful [sic] people I meet in the corporate world are real A…holes!! I’m not saying its [sic] right, but results bring success… [Food Technologist].

Some of the open-ended responses corroborated the importance of personal attributes such as assertiveness and emotional intelligence. One participant highlighted the perceived importance of intellectual curiosity as a personal attribute by stating that “curiosity is a main attribute as this enables learning and further improvement for the individual and business” [Food Technologist].

The importance of career management is highlighted by Bridgstock (2009:31) who says that “…for optimal economic and social outcomes, graduates must be able to proactively navigate the world of work and self-manage the career building process”. Although this aspect is not necessarily a personal attribute, it is a graduate attribute which will benefit the graduate and the employer. However, in terms of the criteria

<table>
<thead>
<tr>
<th>Personal attributes</th>
<th>‘All’ (%) high importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q9: Show sensitivity, respect and empathy towards the feelings and positions of others.</td>
<td>69.3</td>
</tr>
<tr>
<td>Q10: Be humble and grounded.</td>
<td>63.0</td>
</tr>
<tr>
<td>Q16: Global awareness in terms of general knowledge.</td>
<td>56.0</td>
</tr>
<tr>
<td>Q19: Likeability, including a warm, friendly and cooperative manner.</td>
<td>49.4</td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance.
used for this study, ambition was not perceived to be an essential personal attribute. Despite this, analysis of the written comments showed that graduates should take responsibility for their careers as captured in the following two statements:

Get off your backside and do your job. Too many young persons [sic] want to worm their way out of their challenging responsibilities and then aspire to be the CEO in 2 lazy seconds [Food Technologist].

Sense of responsibility and accountability for their own careers [Food Scientist].

Birkett (1996:10) suggests that personal attributes can be divided into cognitive skills and behavioural skills (refer to Figure 2.6). Cognitive skills comprise technical skills, constructive analytical skills, such as problem-solving skills, and appreciative skills, such as critical thinking skills. Behavioural skills comprise personal, interpersonal and organisational skills. Based on Birkett’s ‘Skills Taxonomy’ (Birkett, 1996:10) and the other literature reviewed about personal attributes required by graduates to meet stakeholder expectations, including employability (refer to Table 2.3), the findings of the personal attribute statements provided in the survey were further clustered together into the following groups:

- **Personal qualities**, dispositions and values
- **Emotional intelligence**, self- and social awareness and relationship management or interpersonal skills
- **Self-management skills** and organisational skills
- **Global, commercial and occupational awareness**

Clustering personal attributes according to these four groups allowed identification of possible overlap, or similarity with other graduate attribute statements captured in those sections of the survey probing ‘Leadership and Management’ skills (refer to 4.3.2.3) and ‘Diversity Management’ skills (refer to 4.3.2.4). Based on the results of the clustering (refer to Annexure L), some items in the **personal qualities**, dispositions and values, and **emotional intelligence** clusters were seen to be of ‘high importance',
while all the **self-management skills** provided were perceived as required attributes in terms of the criteria adopted for this study. There was also consensus between ‘All’ participants regarding the percentage ‘high importance’ responses observed for ‘overlapping’ survey statements such as:

- **Common-sense and logical approach** (92.7%) and **critical thinking** (91.9%)
- **Managing stress** (87.6%) and **managing work pressures** (88.1%)
- **Show sensitivity, respect and empathy** towards the feelings and positions of others (69.3%) and **considerate of the concerns and positions of others** (68.6%)

The findings of this section of the survey probing the personal attributes required of food scientists and technologists suggest that time management can be viewed as a subcomponent of self-management or personal management (Al-Alawneh, 2009:37 & 137). This view is supported by the Jordan National Strategic Plan of Education which recognises two categories of employability skills, namely academic skills and self-management skills (Al-Alawneh, 2009:37). According to Al-Alawneh (2009:37), the self-management skills include:

- positive attitudes and behaviours, including self-estimation, integrity and initiative;
- responsibility, including time management, accountability, decision-making;
- accommodation, which includes being innovative, creative and adaptive; and
- team work, which requires working in a team in problem-solving, understanding the needs of employers and participating in making decisions.

### 4.3.3.1 Summary of the findings: Personal attributes

Positive personal attributes are recognised as a prerequisite to successful employability (Pandit et al., 2015:303). One must keep in mind that personal dispositions and qualities are recognised to be specific to the field of study and/or the occupation, vocation or profession (Barnett, 2009:434), and this section of the survey aimed to identify the mix of personal attributes required to be an effective food scientist and technologist within the South African context. Table 4.7 summarises the
essential personal attributes, clustered into three broader categories, namely personal qualities, dispositions and values, self-management and organisational skills and emotional intelligence. These attributes are required of food science and technology graduates in terms of the criteria adopted for this study. Table 4.7 also shows adjectives describing the personal attributes that were used for thematically coding and analysing open-ended responses to survey questions.

Table 4.7: Summary of the perceived required personal attributes

<table>
<thead>
<tr>
<th>Needed personal attributes</th>
<th>Adjective describing the attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal qualities, dispositions and values</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accountable and responsible,</strong> including the ability to admit to mistakes and accept and carry out instructions in a constructive manner.</td>
<td>• Responsible, reliable, conscientious</td>
</tr>
<tr>
<td><strong>Common-sense and logical approach</strong> to society and the workplace including the ability to analyse/solve problems and reflect on and evaluate situations and own performance.</td>
<td>• Logical</td>
</tr>
<tr>
<td><strong>Confidence</strong> in dealing with challenges in an assertive, firm and positive manner.</td>
<td>• Self-confident, assertive, self-assured</td>
</tr>
<tr>
<td><strong>Creativity</strong> and the ability to be original, inventive and to apply lateral thinking.</td>
<td>• Inventive, creative</td>
</tr>
<tr>
<td><strong>Display high energy with a ‘can do’ approach,</strong> take on tasks, set goals and continually enhance work performance level.</td>
<td>• Willing, energetic</td>
</tr>
<tr>
<td><strong>Ethical sensitivity and integrity</strong> including trustworthiness and behaving honestly and fairly, making positive use of rules and/or values and exhibiting good work ethics.</td>
<td>• Ethical, trustworthy</td>
</tr>
<tr>
<td><strong>Intellectual curiosity, eagerness to learn and commitment to ongoing learning</strong> to meet the needs of employment and life including the ability to identify opportunities for life-long learning and learn new skills as required by the workplace.</td>
<td>• Curious, inquisitive</td>
</tr>
<tr>
<td><strong>Pay attention to detail</strong> and like to do things properly.</td>
<td>• Fastidious, meticulous</td>
</tr>
<tr>
<td><strong>Perseverance, resilience and adaptable</strong> to changing situations.</td>
<td>• Perseverant, resilient, Adaptive, flexible</td>
</tr>
<tr>
<td>Needed personal attributes</td>
<td>Adjective describing the attribute</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td><strong>Positive attitude</strong></td>
<td>• Positive, optimistic, resilient</td>
</tr>
<tr>
<td>and belief that capabilities e.g. intelligence and attitudes can be continually developed.</td>
<td></td>
</tr>
<tr>
<td><strong>Professionalism</strong></td>
<td>• Professional identity</td>
</tr>
<tr>
<td>including presenting a positive personal image.</td>
<td></td>
</tr>
<tr>
<td><strong>Self-motivated</strong></td>
<td>• Self-motivated, enthusiastic, resourceful, proactive</td>
</tr>
<tr>
<td>and demonstrate initiative.</td>
<td></td>
</tr>
<tr>
<td><strong>Self-management and organisational skills</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Prioritising, setting goals</strong> and planning</td>
<td>• Organisational skills, time-management skills</td>
</tr>
<tr>
<td>a structured course of action to achieve goals by ranking tasks according to importance (time- and self-management skills).</td>
<td></td>
</tr>
<tr>
<td><strong>Self-management</strong></td>
<td>• Self-management skills</td>
</tr>
<tr>
<td>and the ability to multi-task.</td>
<td></td>
</tr>
<tr>
<td><strong>Manage stress</strong></td>
<td>• Self-management skills</td>
</tr>
<tr>
<td>through demonstrating the ability to retain effectiveness under pressure.</td>
<td></td>
</tr>
<tr>
<td><strong>Work independently</strong></td>
<td>• Independent</td>
</tr>
<tr>
<td>with little supervision.</td>
<td></td>
</tr>
<tr>
<td><strong>Emotional intelligence, self- and social awareness and relationship management</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accept criticism</strong></td>
<td>• Positive attitude</td>
</tr>
<tr>
<td>without retaliating negatively.</td>
<td></td>
</tr>
<tr>
<td><strong>Self-aware</strong></td>
<td>• Self-awareness, self-esteem, self-confidence</td>
</tr>
<tr>
<td>of own strengths, weaknesses, aims and values.</td>
<td></td>
</tr>
</tbody>
</table>

Many of the personal attributes perceived as being of ‘high importance’ by ‘All’ participants are defined as intrinsic personality traits and are not skills or capabilities, per se. As such, the role of higher education in developing these attributes may be limited (Tyman, 2013:846 & 853). However, Barnett (2009:434) proposes that higher education can develop and enhance the dispositions and qualities of graduates, especially the ability to use initiative and to be adaptable (Fugate et al., 2004:13; Fuller & Marler, 2009:329; Rae, 2007:607). The intrinsic personality traits perceived as of ‘high importance’ and required for successful employability can possibly be used to develop selection criteria to assess applicants for enrolment into qualifications in the discipline of food science and technology. Based on these findings and the proposed relationship between employability and self-esteem and self-confidence (Potgieter, 2012:Discussion), developing the personal attributes of self-esteem and self-confidence were identified as a possible challenge.
4.4.4 Fundamental food science and technology-specific knowledge, skills and competencies

The purpose of this section of the survey was to probe and identify the perceived discipline-specific cognitive knowledge, technical skills and ‘core’ competencies that food scientists and technologists should have acquired as learning outcomes during their undergraduate studies. To accomplish this purpose, the respective responses from the ‘Food Scientist’ career category participants were analysed to determine the requirements for food scientists, and the responses from the ‘Food Technologist’ career category participants were used in the determination for food technologists. This categorisation allowed the findings to be compared to see if the broad discipline-specific knowledge, skills and competencies deemed necessary to be an effective food scientist and those perceived as required of food technologists were the same (as was assumed in section 4.3), or whether they differ. The responses for the ‘Other’ career category participants were not further analysed as it was decided to exclude their responses for the food science and technology discipline-specific sections of the survey (see 4.2.2).

Seeing that this research is mainly explorative in nature, descriptive analysis was once again used as the method of analysis for the data collected in the subsections dealing with the different areas of discipline-specific fundamental or essential cognitive knowledge, technical skills and competencies. Participants were informed that all questions were optional – this was to allow those participants without a higher education qualification in food science and technology to abstain from those subsection/s in which they did not feel confident of having the necessary knowledge and experience to give meaningful answers. The food science and technology discipline-specific areas included in this section of the questionnaire were identified through a comprehensive literature review (refer to Table 2.2). The formulation of the draft survey questions as learning outcomes was informed by the literature review and the content of the IUFoST reference book (Campbell-Platt, 2018:1-534). It was later also confirmed through the focus group discussions for applicability in the South African context (refer to 3.3.3.2).
The finalised questionnaire consisted of questions in the following discipline-specific areas (refer to Table 3.2):

- Food analysis: Analytical, biochemical and chemical
- Food analysis: Microbiological
- Sensory analysis
- Food chemistry
- Nutrition
- Food regulation and control, including legislation
- Food microbiology, including general microbiology
- Food packaging
- Food processing
- Food engineering
- Food product development
- Food safety and quality management
- Applied food science and technology

The required knowledge, skills and competencies for each subsection were again identified using the criteria of 80 percent and above of ‘high importance’ responses to indicate an essential learning outcome.

4.4.4.1 Food analysis: Analytical, biochemical and chemical

Food analysis is named as a ‘core competency’ of undergraduate food science and technology qualifications (Campbell-Platt, 2018:31; IFT, 2011:5-8). Therefore, based on the literature reviewed (refer to Table 2.2 & 2.3.4.5 a) and the outcome of the focus group discussions (refer to 3.3.3.2), the questions in Table 4.8 were presented to the participants.
The following food analysis knowledge, skills and competencies were perceived to be required of both food scientists and food technologists:

- the ability to construct a food analysis report which records the results of the food analysis, including an interpretation of the results and drawing scientific conclusions from the results; and
- the ability/skill to interpret a food analysis report and take proper actions based on the findings and conclusions in the report.

In addition, the knowledge, skills and competencies to analyse the quality aspects of food products and to determine the shelf-life of products were identified as essential to food technologists in terms of the criteria used for this study.
Overall, the findings show that there are similar expectations for both food science and food technology graduates. More advanced food analysis methods, including molecular methods, were perceived of lesser importance by both the ‘Food Scientist’ and ‘Food Technologist’ career category participants. This could be because these advanced techniques are complex and costly to conduct and are not currently routinely used for food analysis in South Africa. However, molecular techniques are becoming progressively important to confirm food authenticity and in species identification due to incidents of food fraud (Espíñeira & Santaclara, 2016:91; Burns, Wiseman, Knight, Bramley, Foster, Rollinson, Damant & Primrose, 2015:1-2; Pleitner, Hammons, McKenzie, Cho & Oliver, 2014:13). The increasing complexity of food chains has also led to an enhanced focus on the use of molecular techniques for traceability of food and beverage products, ingredients and raw materials to ensure the safety and quality of food products. In addition, traceability must meet the criteria of food safety management systems such as the International Organization for Standardization standard (ISO 22000:2018). Due to these pressures, the ability to practice molecular techniques is proposed to become increasingly important and should be part of the food science and technology programme content (Espíñeira & Santaclara 2016:91).

Content analysis of the data provided in response to the question asking for additional important food analysis knowledge, skills and competencies, did not identify anything that was not already covered in the survey questions. Participants did, however, observe that the level to which a graduate is required to demonstrate food analysis knowledge, skills and competencies will differ depending on the job requirements of the position into which the graduate is employed through comments such as the “skills required vary greatly depending on which sector of the food industry the food scientist works in, as well as the department they work in” [Food Scientist].

The essential requirement for graduates to be able to construct a food analysis report, interpret the results obtained through food analysis and recommend and take appropriate action (refer to Table 4.8, questions 8 & 9) was collaborated through several comments including, “interpretation [of the results of food analysis] and the subsequent action required is important” [Food Scientist].
4.4.4.2 Food analysis: Microbiological

In this subsection, the responses to the survey questions measuring the perceived importance of food microbial analysis, which was determined to be a critical aspect of food science and technology education (refer to Table 2.2; & 2.3.4.5 f), were under the spotlight. The findings are summarised in Table 4.9.

Table 4.9: Food analysis: microbiological: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food analysis: Microbiological</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% High Importance</td>
<td>% High Importance</td>
</tr>
<tr>
<td>Q1: Understand the principles, source, select and perform microbial methods and/or techniques to identify and enumerate microorganisms in foods and related products.</td>
<td>75,7</td>
<td>75,4</td>
</tr>
<tr>
<td>Q2: Make use of rapid microbiological methods and/or techniques to e.g. monitor safety and quality of foods and monitor the effectiveness of cleaning and sanitation.</td>
<td>62,3</td>
<td>70,5</td>
</tr>
<tr>
<td>Q3: Demonstrate practical proficiency when performing microbial analysis.</td>
<td>65,2</td>
<td>71,7</td>
</tr>
<tr>
<td>Q4: Source, select and perform microbial analysis to determine the expected microbial shelf-life of food and related products.</td>
<td>71,1</td>
<td>72,1</td>
</tr>
<tr>
<td>Q5: Construct a food microbial analysis report to record results of analysis, interpret results and draw conclusions.</td>
<td>76,8</td>
<td>86,9</td>
</tr>
<tr>
<td>Q6: Conduct microbial molecular techniques such as Polymerase Chain Reaction (PCR), gel electrophoresis, DNA microarrays, to detect micro-organisms in foods.</td>
<td>29,4</td>
<td>29,5</td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance

It seems that for this subsection, only one skill was perceived as being of ‘high importance’ in terms of the criteria adopted for this study, and then only for food technology graduates. The skill deals with the ability to construct a food microbial analysis report recording the results of analysis, interpreting the results and the drawing of conclusions from the report.

Corroborating the findings for food analysis other than microbial analysis, the ability to perform more advanced molecular techniques such as PCR, gel electrophoresis and deoxyribonucleic acid (DNA) microarrays to detect micro-organisms in foods was not perceived as being of ‘high importance’ by either the ‘Food Scientist’ or ‘Food
Technologist’ career categories. However, due to the increasing demand for rapid results, molecular techniques are more frequently being applied for the detection of micro-organisms in foodstuffs (Ceuppens, Li, Uyttendaele, Renault, Ross, Van Ranst, Cocolin & Donaghy, 2014:551). This implies that it should be part of the food science and technology programme content to ensure currency as it is expected that the need for these more advanced skills will grow in the future.

Content analysis of the data collected through the open-ended responses did not identify any additional microbial food analysis knowledge, skills and competencies that were not captured in the questionnaire items in this subsection, or the subsection probing food safety knowledge, skills and competencies. The perspective that the importance and level of microbial analysis skills are linked to the exact role the graduate would be employed to fulfil was expressed by a participant who observed that “these [food analysis: microbiological] competencies may be deemed moderately, very or extremely important” [Food Technologist].

4.4.4.3 Sensory analysis

Sensory analysis of foods and beverages was identified through literature as required knowledge, skills and competencies (refer to Table 2.2 & 2.3.4.5 b). This subsection reports on the findings based on the percentage of responses to the sensory analysis questions (see Annexure F, item 4.6).

The perceived ‘high importance’ of sensory analysis knowledge, understanding and competencies are shown in Table 4.10. In terms of the criteria adopted for this study, only the 'Food Technologist' participants identified the ability to make use of good sensory laboratory practices when conducting sensory analysis as a perceived essential competency. This finding is surprising in that the use of good laboratory practices goes hand-in-hand with the other two statements provided in the subsection.
Table 4.10: Sensory analysis – Percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Sensory Analysis</th>
<th>Food Scientists % High Importance</th>
<th>Food Technologists % High Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1:</strong> Identify, select and conduct appropriate sensory analysis methods for different applications including quality control and assurance, new product development, and shelf-life studies</td>
<td>75,4</td>
<td>75,8</td>
</tr>
<tr>
<td><strong>Q2:</strong> Collect, analyse and interpret the data and results collected using different sensory analysis methods</td>
<td>71,0</td>
<td>75,8</td>
</tr>
<tr>
<td><strong>Q3:</strong> Make use of Good Sensory Laboratory Practices when conducting sensory analysis</td>
<td>72,5</td>
<td><strong>80,6</strong></td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance

Content analysis of the open-ended responses provided by the participants did not identify any additional sensory analysis knowledge, skills and competencies that were not already captured in the survey items (refer to Table 4.10). Participants did highlight that graduates should be more aware of the difference between internal company sensory analysis by an individual or an internal company expert panel, and broader external consumer testing utilised in food product development. A participant said, “understanding the differences between internal sensory analyses and external sensory analyses” [Food Technologist].

The importance of sensory analysis knowledge, skills and competencies was emphasised through the open-ended responses from the participants including the “basic knowledge of the principles of sensory analysis of foods [is] very important” [Food Scientist]. A Food Technologist participant observed that “sensory analysis is key in determining the correct organoleptic properties [of foods]. Therefore these [sensory analysis knowledge, skills and competencies] may be deemed as very important”.

When considering the analysis of the comments provided by the participants and the emphasis on the requirement for sensory evaluation as a required learning outcome of food science and technology undergraduate programmes (refer to Table 2.2), it can be concluded that sensory analysis knowledge, skills and competencies must be part of food science and food technology undergraduate programmes. However, the type and level of sensory analysis knowledge, skills and competencies required by
graduates will ultimately be associated with the “…*type of work the employee will be conducting*…” [Food Scientist].

### 4.4.4.4 Food chemistry

Food chemistry (refer to 2.3.1.5c) was identified as a necessary element of any undergraduate food science and technology programme (refer to Table 2.2). Based on the reviewed literature, questions were formulated and later confirmed through a focus group discussion to measure the required food chemistry knowledge, skills and competencies (see Annexure F, item 4.7). Table 4.11 summarizes the percentage of ‘high importance’ responses to each of the questions:

**Table 4.11: Food chemistry: Questions and percentage ‘high importance’ responses**

<table>
<thead>
<tr>
<th>Food Chemistry</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Identify the functional properties of food components within foods and select food ingredients to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life).</td>
<td>91,3 % High Importance</td>
<td>90,3 % High Importance</td>
</tr>
<tr>
<td>Q2: Describe the structure and apply the chemistry of food components to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life) during processing, storage, distribution and sale.</td>
<td>81,2 % High Importance</td>
<td>83,9 % High Importance</td>
</tr>
<tr>
<td>Q3: Apply knowledge to interpret results from food analysis in order to measure, control, modify and improve the required product attributes.</td>
<td>91,3 % High Importance</td>
<td>83,9 % High Importance</td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance

All the survey items were perceived as required knowledge, skills and competencies to both food scientists and food technologists in terms of the criteria adopted for this study. This finding corroborates the reviewed literature (refer to Table 2.2) which identified food chemistry as an essential requirement for food science and technology undergraduate qualifications.

Content analysis of the responses to the open-ended questions did not identify any additional food chemistry knowledge, skills and competencies not already captured in the survey questions (refer to Table 4.11). However, one participant expressed that “…*it
is often not enough to understand ingredient functionality but also how processing conditions may influence their performance within a food system” [Food Technologist]. The role of processing conditions on food components was not specifically captured in this subsection but was included in the subsection probing the necessary food processing knowledge, skills and competencies. The essential need to interpret the results of food analysis was reinforced (see Table 4.8, questions 8 & 9; Table 4.9, question 5; Table 4.10, question 2) by a participant said that “interpretation of results and identifying further actions is critical” [Food Scientist]. Another participant voiced the opinion that food chemistry “is an area where newly qualified food scientists are often lacking, particularly in regard to applying food chemistry knowledge to practical situations” [Food Scientist]. This comment implies that food chemistry knowledge, skills and competencies, and especially the application to practice, may be a potential area for improvement.

4.4.4.5 Nutrition

Human nutrition and food nutritional quality were identified in the literature as essential components of food science and technology undergraduate qualifications (refer to Table 2.2). In this subsection of the study, participants were presented with questions to measure the perceived importance of certain aspects of nutrition (Annexure F, item 4.8). The findings are reported in Table 4.12.

Table 4.12: Nutrition – Questions and percentage ‘high importance’ responses

<table>
<thead>
<tr>
<th>Nutrition</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1:</strong> Outline the fundamentals of human nutrition and describe the nature of foods, food selection and food groups in nutrition.</td>
<td>59,1</td>
<td>60,0</td>
</tr>
<tr>
<td><strong>Q2:</strong> Identify how nutrients in food impact health and wellness positively and negatively including sugar (obesity, heart disease, diabetes), salt (hypertension, cardiovascular disease), dietary fats and other activities.</td>
<td>62,7</td>
<td>73,4</td>
</tr>
<tr>
<td><strong>Q3:</strong> Identify the nutritional requirements of different population groups in terms of energy, health and wellness in order to avoid under- or over-nutrition and apply this knowledge in new product development.</td>
<td>40,3</td>
<td>53,3</td>
</tr>
<tr>
<td><strong>Q4:</strong> Understand and apply knowledge of food allergies in all areas of food manufacture from product</td>
<td>82,1</td>
<td>91,5</td>
</tr>
</tbody>
</table>
When considering the findings presented in Table 4.12, the following items were perceived to be of ‘high importance’, and thus essential for both food scientists and food technologists:

- understand and apply knowledge of food allergies in all areas of food manufacture from product development and selection of ingredients through production, packaging and labelling; and
- understand and apply nutrition principles to food product development and food formulation, and develop a correct nutritional table to appear on a product label.

The perceived essential need to understand and apply knowledge of food allergens in food processing and food product development (refer to Table 4.12, question 4) may possibly be explained in terms of the increasing importance of food allergen risk assessment and risk management in food safety (ILSI, 2011:4; Madsen, Crevel, Mills & Taylor, 2014:xix). South African food labelling legislation requires that food labels must identify major allergens to present enough information for consumers to manage the risks of food allergies when making food choices (SA DOH, 2010:27, para. 43-47). Furthermore, food safety management systems such as ISO 22000 (2018, para. 3.22) classify food allergens as a food safety hazard and require that a food allergen control programme must be in place in food manufacturing facilities to prevent food allergen cross-contamination.
Analysis of the open-ended responses did not identify any additional nutritional knowledge, skills and competencies not captured by the questionnaire items. However, the open-ended responses supported the essential requirement for food science and technology graduates to be able to apply nutritional principles in food product development. Participants commented that these graduates “…needs to realize the role they play in the human health and selection of food as well as portion sizes” [Food Scientist]. Another participant stated that “nutritional demands and the delivery thereof within food systems are important in the development of products for today’s market needs” [Food Technologist]. The aspect of applying nutritional principles in food product development was captured in a subsequent subsection.

Some participants highlighted the need for food science and technology graduates to be able to interact effectively with nutritionists when specialist knowledge is required. This was demonstrated through comments such as the “ability to interact with nutritional professionals (nutritionists / dieticians)” [Food Scientist] and “good knowledge on [sic] nutrition is important, this function should be outsourced if contentious issues arise” [Food Technologist].

A Food Scientist participant stated that the level of nutritional knowledge, skills and competencies necessary would “be dependent on the area in which the employee is working…”, but made the further observation that “…it is an increasingly important component of food science and technology”.

4.4.4.6 Food regulation and control, including legislation

Food control and regulation (see 2.3.1.5e) were identified through the literature review as being required knowledge, skills and competencies for food science and food technology graduates (refer to Table 2.2). Based on the reviewed literature and the findings of the focus group discussions, four questions were constructed to probe the perceptions of the survey participants about the essential learning outcomes necessary for food control and regulation (see Annexure F, item 4.9) as shown in Table 4.13.
Both competency statements perceived as being of ‘high importance’ referred to the knowledge, understanding and application of South African food legislation to food product development, food manufacturing, food packaging, food labelling and sale of food products. The ability to find and retrieve information other than South African legislation was important, but not essential, in terms of the criteria adopted for this study. However, information retrieval as an essential generic graduate attribute associated with employability has already been identified as essential in terms of this study (refer to Figure 4.2). With the increasing globalisation of the food and beverage trade, food and related products must usually meet the legislative requirements of the country of manufacture and the country of sale if these are not aligned (FAO & WTO, 2017:3i), and information retrieval skills would be required to ensure compliance. Furthermore, global organisations such as the Codex Alimentarius Commission (CAC), the Food and Agricultural Organisation of the United Nations (FAO) and the World Trade Organisation (WTO) supply useful resources, including food standards which are reference points aimed at ensuring consumer safety and confidence, food security and fair trade (FAO & WTO, 2017:3). Thus, the ability to search, find and interpret globally available documentation such as food standards, codes of

<table>
<thead>
<tr>
<th>Food regulation and control</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Describe the scope, application and influence of global and national food regulation and control initiatives.</td>
<td>71.6</td>
<td>71.2</td>
</tr>
<tr>
<td>Q2: Locate global food safety and quality codes of practice, guidelines and related documentation (e.g. Codex documentation).</td>
<td>77.6</td>
<td>79.7</td>
</tr>
<tr>
<td>Q3: Demonstrate understanding of food regulation and control in the Republic of South Africa (SA) and locate, interpret and apply relevant SA legislation that regulates the safety and quality of agricultural, food and beverage products from product and formulation development through manufacturing, packaging, labelling, distribution and sale.</td>
<td>88.1</td>
<td>89.8</td>
</tr>
<tr>
<td>Q4: Critique a food product label against the SA legislative requirements and/or develop a food label that meets the requirements of SA legislation.</td>
<td>83.6</td>
<td>88.1</td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance.*
practice and guidelines could be considered a necessary skill for food science and technology graduates.

Content analysis of the open-ended responses indicates a possible additional food regulation and control competency, namely “requesting/proposing an amendment of a food regulation or commenting on a published proposed regulation” [Food Scientist]. In addition, the requirement to understand the role of various national regulatory bodies involved with food regulation and control (refer to Table 4.13, question 3) was captured more explicitly through comments such as “…demonstrate knowledge of how to access relevant food regulations and which Government Departments are responsible for making and enforcing the regulations” [Food Scientist].

A Food Scientist participant voiced the opinion that “In a recently graduated person one would not expect a detailed knowledge of regulations” and further commented that “…advanced knowledge will come if the person is working in an environment that requires more in depth [sic] knowledge”. This was supported by another participant who stated “it may not be realistic to expect a newly qualified food scientist to possess significant expertise, however the ability to assimilate the necessary knowledge and apply it is important” [Food Scientist]. Another Food Scientist participant suggested that to encourage teaching and learning of food regulation and control knowledge, skills and competencies, higher education institutions should “…assist students to create their own Portfolio of Evidence type of file where most of the different types of food products are listed, examples of labels [are provided] as well as limits and legal requirements”.

4.4.4.7 Food and general microbiology

The literature reviewed identified microbiological knowledge, skills and competencies (refer to 2.3.1.5f) as essential for the processing and distribution of safe, quality food and beverage products (Bejarano, 2017:00114; Gill, 2017:1) and a requirement of undergraduate food science and technology undergraduate qualifications (refer to Table 2.2). Questions were formulated to measure the perceived ‘high importance’ of
microbiology related to food and allied products, and the percentage of ‘high importance’ responses is reported in Table 4.14.

Table 4.14: Food and general microbiology: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food and general microbiology</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1:</strong> Classify and describe micro-organisms including those that can be used to produce fermented foods, influence microbial safety (i.e. pathogens causing foodborne illness) and quality in foods (i.e. spoilage organisms).</td>
<td>73.9%</td>
<td>81.4%</td>
</tr>
<tr>
<td><strong>Q2:</strong> Demonstrate learning of the role and significance of intrinsic (pH, aw, nutrients, etc.) and environmental/extrinsic parameters (temperature of storage, atmosphere of storage, etc.) and apply this knowledge to promote microbial growth (e.g. fermented foods, destroy micro-organisms and/or inhibit microbial growth).</td>
<td>86.2%</td>
<td>84.7%</td>
</tr>
<tr>
<td><strong>Q3:</strong> Understand the factors that lead to foodborne illness and implement strategies and systems to prevent/limit the incidence of foodborne illness.</td>
<td>93.7%</td>
<td>93.2%</td>
</tr>
<tr>
<td><strong>Q4:</strong> Manipulate parameters and apply microbial and processing knowledge of food preservation techniques such as pasteurisation, heat sterilisation, irradiation, freezing, etc. to ensure the microbial stability and safety of foods and related products.</td>
<td>90.8%</td>
<td>94.9%</td>
</tr>
<tr>
<td><strong>Q5:</strong> Describe and predict the microbial spoilage patterns of foods and related products and implement strategies and systems to obtain the required shelf-life.</td>
<td>78.5%</td>
<td>88.1%</td>
</tr>
<tr>
<td><strong>Q6:</strong> Develop microbiological criteria or specifications for raw materials and finished products.</td>
<td>73.9%</td>
<td>84.5%</td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance

As can be seen from the results shown in Table 4.14, the ‘Food Technologist’ career category participants indicated all the survey questions were necessary knowledge, skills and competencies for food technology graduates. In contrast, the ‘Food Scientist’ career category participants did not perceive the following to be essential to food scientists: The ability to classify and describe micro-organisms; the ability to apply microbial knowledge to prevent food spoilage and extend shelf-life; and, the development of microbial criteria as essential. However, when reviewing the knowledge, skills and competencies represented in the questions (Table 4.14, questions 1, 5 & 6), they were identified as prerequisites for the knowledge, skills and competencies perceived as essential. This implies that all the skill statements
investigated can be considered as essential to both food scientists and food technologists, and should be part of the syllabi and content of microbiology and food microbiology modules.

Analysis of the open-ended responses indicated that participants strongly associated general and food microbiology knowledge, skills and competencies with food safety, which was probed as a separate subsection in the survey. This association was demonstrated through the following comments related to microbial risk analysis and management:

*A strong appreciation of microbiological risk analysis as a vital forerunner to microbial risk management and implementation of HACCP and related programmes is a necessary competence* [Food Scientist].

Another Food Scientist participant suggested that “*students should be required to read reports of significant incidents of food poisoning involving pathogens in history, how these were investigated and what measures/regulations were adopted to avoid recurrence*”.

### 4.4.4.8 Food packaging

This section reports the responses to the questions measuring the perceived ‘high importance’ of certain aspects of food packaging knowledge, skills and competencies (refer to 2.3.1.5 g). As evident from Table 4.15, none of the provided survey questions was perceived as required knowledge, skills and competencies for food scientists in terms of the criteria used in this study. However, the ‘Food Technologist’ career category identified one essential requirement, namely the ability to identify the properties and uses of packaging materials to meet several food product requirements, including product safety and quality, and marketing and consumer requirements.
### Table 4.15: Food packaging: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food Packaging</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% High Importance</td>
<td>% High Importance</td>
</tr>
<tr>
<td>Q1: Identify the basic properties and uses of various packaging materials and</td>
<td>58.7</td>
<td>87.9</td>
</tr>
<tr>
<td>compare and select appropriate packaging systems to meet requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(including product safety, quality, preservation, convenience, marketing,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consumer needs, etc.).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2: Identify new and innovative packaging materials and packaging technologies</td>
<td>54.8</td>
<td>65.6</td>
</tr>
<tr>
<td>and assess their applicability to existing products and new product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>development.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3: Evaluate the sustainability and environmental aspects of packaging</td>
<td>57.1</td>
<td>70.2</td>
</tr>
<tr>
<td>materials and apply this to minimise waste and limit environmental impact.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4: Design and develop a food package prototype in new food product</td>
<td>50.8</td>
<td>64.9</td>
</tr>
<tr>
<td>development and conduct experiments to validate a packaging system or material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>is meeting the requirements of the product.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance.

The environmental aspects of food packaging (refer to Table 4.15, question 3) were not seen as essential for newly graduated food scientists and technologists in terms of the criteria adopted for this study. However, sustainability, waste prevention and the environmental impact of packaging material are increasingly under the spotlight (Marsh & Bugusu, 2007:44; Pongrácz, 2007:253; Siracusa, Ingrao, Giudice, Mbohwa & Rosa, 2014:160). It is therefore recommended that the sustainability and environmental impact of food packaging should be incorporated into the programme content to highlight the importance of environmental responsibility in food packaging.

Analysis of the open-ended responses reinforced the findings that it is essential for food scientists and technologists to have broad and fundamental rather than in-depth knowledge, skills and competencies of food packaging (refer to Table 4.15, question 1). Participants said: “*Unless the person is intending to go on to fulltime research or development, more than a basic knowledge of food packaging is not necessary - this could be a specialisation*” [Food Scientist].
Two aspects were raised that were not explicitly captured in the survey items. One was related to the importance of packaging seals and closures, expressed through the comment:

A factor applicable to all food packaging is sealing...It is necessary to fully understand the conditions that need to be met in order for the required level of seal to be consistently achieved and how this is to be specified and monitored [Food Technologist].

Seals and closures are indeed an important aspect of packaging that will influence food safety and quality management (Nestmann, Lynch, Musa-Veloso, Goodfellow, Cheng, Haighton & Lee-Brotherton, 2005:875). It would require consideration in the risk analysis when developing, implementing, monitoring and continually improving food safety and quality systems.

The second aspect raised was consideration of risk assessment of food packaging materials (Muncke, 2010:123) and food and packaging interactions (Arvanitoyannis & Kotsanopoulo, 2014:21) when conducting risk analysis for the management of food safety and quality. This was captured by a Food Scientist participant who expressed the opinion that food packaging knowledge, skills and competencies “should include some appreciation of the basics of toxicology and risk assessment of new [packaging] materials”.

Both these aspects should be considered as additional food packaging knowledge, skills and competencies required due to their impact on food safety.

4.4.4.9 Food processing

Based on the literature reviewed certain aspects of food processing (refer to Table 2.2 & 2.3.1.5 h) knowledge, skills and competencies were formulated as questions for inclusion in this subsection of the survey. This section outlines the 'high importance' responses to these questions (see Appendix F, item 4.12) in Table 4.16.
Table 4.16: Food processing: Questions and percentage ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food Processing</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Describe the source and variability of raw food materials and select suitable raw food materials for various food processing and preservation operations.</td>
<td>72,3% High Importance</td>
<td>83,9% High Importance</td>
</tr>
<tr>
<td>Q2: Identify the spoilage and deterioration mechanisms in foods and apply the food processing and preservation principles to increase shelf-life, retain sensory, quality and nutritional properties and produce safe food products.</td>
<td>85,9% High Importance</td>
<td>94,6% High Importance</td>
</tr>
<tr>
<td>Q3: Demonstrate learning of the unit operations generally associated with food processing (e.g. mixing, extrusion, heat processing and preservation, freezing, dehydration, evaporation, etc.) and select the unit operations required to develop a process flow to produce a given food product.</td>
<td>78,5% High Importance</td>
<td>89,3% High Importance</td>
</tr>
<tr>
<td>Q4: Evaluate the requirements for water utilisation and waste management in food processing factories.</td>
<td>47,7% High Importance</td>
<td>69,9% High Importance</td>
</tr>
<tr>
<td>Q5: Determine the effects of processing parameters on product safety and quality.</td>
<td>87,7% High Importance</td>
<td>82,3% High Importance</td>
</tr>
<tr>
<td>Q6: Design and maintain time and production schedules/records.</td>
<td>47,6% High Importance</td>
<td>58,9% High Importance</td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance.

The results reported in Table 4.16 show that the participants perceived the following items as being of ‘high importance’:

- The overlapping knowledge, skills and competencies represented in questions two and five, which deal with the use of processing technologies to produce safe, nutritious and quality foods, were perceived as essential by both ‘Food Science’ and ‘Food Technology’ participants.
- Two further skill questions were perceived as essential by the ‘Food Technologist’ participants. The first is related to the knowledge, skills and competencies attached to selecting processing technologies or unit operations to produce food products. This is prerequisite knowledge for the two questions perceived as being essential to both food scientists and food technologists (refer to Table 4.16, questions 2 & 5).
- In addition, raw material considerations for various food processing and preservation methods (Table 4.16, question 1) is perceived as essential by ‘Food Technology’ participants only. Again, it can be argued that this is prerequisite
knowledge to manufacture safe, quality foods and should thus be viewed as essential to both food scientists and food technologists.

Content analysis of the responses to the open-ended question provides additional food processing knowledge, skills and competencies not captured in the survey, namely “scaling up [of] small scale samples or processes to commercial scale operations” [Food Scientist]. This ability was included in a questionnaire item under the food product development subsection but is equally relevant to this subsection. The requirement for the knowledge, skills and competencies captured in questions two and five (see Table 4.16) was reinforced through the comment:

In food processing you want to have a clear understanding of why you are applying a given technique, the stages necessary to produce the product in quantities and to the quality required, and the services [utilities]… necessary for each stage [step of processing] [Food Scientist].

A Food Scientist participant stated that food processing knowledge, skills and competencies “is the essence of a food technologist’s applied knowledge…”. Another participant observed that the “skills [food processing knowledge, skills and competencies] required are industry specific” [Food Scientist], and that there is great variability of the required food processing knowledge, skills and competencies depending on the food/s that is/are being manufactured.

4.4.4.10 Food engineering

In this subsection, the analysis of the responses to questions probing the perceived ‘high importance’ of certain aspects of the food engineering knowledge, skills and competencies (see Annexure F, item 4.13) is shown in Table 4.17.
### Table 4.17: Food engineering: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food Engineering</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% High Importance</td>
<td>% High Importance</td>
</tr>
<tr>
<td>Q1: Classify forms of energy and apply the properties of different energy sources, air and water to manage energy requirements of processing operations.</td>
<td>36.9</td>
<td>51.9</td>
</tr>
<tr>
<td>Q2: Apply knowledge of the sustainability and environmental issues around the use of energy; including energy conservation and waste recovery.</td>
<td>40.6</td>
<td>61.1</td>
</tr>
<tr>
<td>Q3: Interpret and apply the concepts of material (mass) and energy balances in food processing systems.</td>
<td>51.6</td>
<td>65.4</td>
</tr>
<tr>
<td>Q4: Determine material (mass) and energy balances for a given processing operation and apply this to understanding profitability.</td>
<td>44.6</td>
<td>59.3</td>
</tr>
<tr>
<td>Q5: Make use of software (e.g. Excel spreadsheets) to calculate and analyse material (mass) and energy balances.</td>
<td>43.1</td>
<td>64.8</td>
</tr>
<tr>
<td>Q6: Determine optimal design factors and operating conditions for food manufacturing operations (e.g. pasteurisation, canning, dehydration, cooling, etc.) in order to obtain the required product attributes.</td>
<td>61.5</td>
<td>79.6</td>
</tr>
<tr>
<td>Q7: Describe and apply the physics of fluid flow as related to food processing systems.</td>
<td>37.5</td>
<td>53.7</td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance.

It seems that for this subsection, none of the identified and provided knowledge, skills and competencies were identified as being of ‘high importance’ for either food science or food technology graduates.

Content analysis of the participant comments reflected the findings reported in Table 4.17 and supported that **fundamental rather than in-depth knowledge of food engineering knowledge, skills and competencies was needed**. Comments supporting this conclusion include: “*basic knowledge of food engineering is essential. More in depth knowledge will come if this is the student’s aptitude and if the working environment requires it*” [Food Scientist]. Another Food Scientist participant commented that “*an appreciation of food engineering is important but a food scientist can work in a team with professional food plant engineers who can deal with the machine design details to meet the product/process parameters*…”

The findings that food engineering knowledge, skills and competencies are not perceived as highly important to food scientists and technologists are corroborated by
Niranjan (2016:1) and Saguy (2016:176). Niranjan (2016:1) suggests that this is not a true reflection of the essential need for food engineering knowledge, skills and competencies but rather due to the fact that food engineering “has been relegated to play the role of a service provider to the food industry” when it should act to purposefully encourage the growth of the industry; a view supported by Saguy, Singh, Johnson, Fryer and Sastry (2013:332).

4.4.4.11 Food product development

In this subsection, the survey participants were presented with questions relating to food product development knowledge, skills and competencies and they were asked to respond by indicating their perceived importance of each (see Annexure F, item 4.14). The questions and the percentage of ‘high importance’ responses to each question are presented in Table 4.18.

Table 4.18: Food product development: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food product development</th>
<th>Food Scientists % High Importance</th>
<th>Food Technologists % High Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Research current trends and new ingredients, process technologies and packaging to</td>
<td>77,8</td>
<td>80,0</td>
</tr>
<tr>
<td>develop new product concepts and prototypes and/or improve existing products.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2: Identify and define the target market needs, wants and requirements in order to</td>
<td>69,8</td>
<td>70,9</td>
</tr>
<tr>
<td>develop the required product attributes for a new food product.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3: Identify and screen product ideas and follow a structured product development process</td>
<td>76,2</td>
<td>80,0</td>
</tr>
<tr>
<td>to develop a product prototype.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4: Develop new or modify existing food products by sourcing and selecting raw materials</td>
<td>79,4</td>
<td>78,2</td>
</tr>
<tr>
<td>and other ingredients and developing product formulations and processing strategies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5: Manipulate formulation input costs to meet product target selling price and prepare</td>
<td>79,4</td>
<td>80,0</td>
</tr>
<tr>
<td>total product costings, including variable and fixed costs to meet a project brief.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q6: Design safety and quality into new or existing food products through raw material/</td>
<td>87,1</td>
<td>90,9</td>
</tr>
<tr>
<td>ingredient selection, process flow development, determining the process parameters,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>packaging, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q7: Determine the shelf-life of product prototypes during the development process.</td>
<td>79,4</td>
<td>85,5</td>
</tr>
</tbody>
</table>
Using the defined criteria to identify essential knowledge, skills and competencies, only one of the eight identified skills was perceived as essential by the ‘Food Science’ career category participants for food science graduates; namely, the ability to incorporate the principles of food safety and quality into food products during the product development process. In comparison, five of the eight skills probed in the survey were perceived as essential by the ‘Food Technology’ participants for food technology graduates. This was a surprising finding, as new product development is an area of focus in some of the current food science and technology undergraduate programmes offered by South African higher education institutions. However, reference to the IFT’s ‘core competencies’ supported this finding. The minimum ‘core competencies’ of food science and technology undergraduate programmes required by this organisation previously included food product development knowledge, skills and competencies as an ‘applied food science’ competency (IFT, 2016:6-8). However, the latest revision no longer reflects this requirement (IFT, 2019:6-8).

In this subsection two ‘interesting’ findings emerged, namely:

- Question four dealt with the ability to develop and modify food formulations to achieve certain objectives such as improving safety, nutrition and/or quality, reducing input costs or complying with changing legislative requirements. According to the defined criteria to indicate essential knowledge, skills and competencies, this was not perceived as essential. However, when analysing the data collected in response to the questions provided in the subsection on applied food science (see 4.4.4.13), this capability was perceived as essential by both Food Scientist and Food Technologist participants.
- Question two probed the need to develop new products based on consumer needs and wants and was not indicated as an essential graduate requirement in terms of the criteria adopted for this study. However, the used consumer information is
viewed as a key factor in the success of new food product design, especially when developing new food technologies and food products (Raleya et al., 2016:39).

In response to the request for any additional food product development knowledge, skills or competencies, participants identified two areas not pertinently investigated in this subsection of the survey, namely project management and food legislation. The essential need for project management knowledge, skills and competencies for food science and technology graduates was already established as a required leadership and management skill (refer to 4.4.2.3). Likewise, the essential need for food legislation and the ability to “locate, interpret and apply relevant SA legislation that regulates the safety and quality of agricultural, food and beverage products from product and formulation development through manufacturing, packaging, labelling, distribution and sale” (see 4.4.4.6) has been previously established.

4.4.4.12 Food safety and quality management

The requirement for food safety was identified as a critical area of required knowledge, skills and competencies for food scientists and technologists (Flores et al., 2010:572; McElhatton & Marshall, 2007:ix; refer to 2.3.4.5 k). This study coupled food safety together with food quality assurance as food safety can be regarded as an element of food quality (Petrović et al., 2017:1). Based on the reviewed literature (see Table 2.2), questions were formulated to probe the perceived necessary food safety and quality knowledge, skills and competencies (See Annexure F, item 4.15). The percentages of ‘high importance’ responses to these questions are shown in Table 4.19.

### Table 4.19: Food safety and quality management: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Food safety and quality management</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1</strong>: Develop and apply Food Safety Objectives to ensure food safety and quality.</td>
<td>% High Importance 87,5</td>
<td>% High Importance 90,7</td>
</tr>
<tr>
<td><strong>Q2</strong>: Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
<td>% High Importance 89,1</td>
<td>% High Importance 96,3</td>
</tr>
</tbody>
</table>
The ‘Food Technology’ career category participants perceived all the presented survey questions as essential food safety and quality management knowledge, skills and competencies. In contrast, only seven of the ten provided questionnaire items were perceived as required by the ‘Food Scientist’ participants. The survey items that were not identified as essential by the ‘Food Scientist’ participants dealt with the location, design and construction aspects of the food processing plant and the food processing equipment, as well as cleaning and sanitation of food manufacturing premises. However, this is prerequisite knowledge that must be applied when implementing a food safety and quality management system (see Table 4.19, question 7) and it can therefore be assumed to be necessary knowledge, skills and competencies.

Analysis of the responses to the open-ended questions revealed that a Food Scientist participant perceived that food safety and quality management knowledge, skills and
competencies are “the most important task of a food technologist”. Further analysis showed that the ability to conduct audits was highlighted in 25 percent of the responses received. In addition, a Food Scientist participant felt that knowledge, skills and competency of “local and international food safety certification procedures and related documentation”, was prerequisite knowledge that should be demonstrated by food science and technology graduates.

4.4.13 Applied food science and technology

The need for food science and technology graduates to be able to effectively apply food science and technology knowledge, skills and competencies in practical situations was identified through literature (Akkermans et al., 2013:258; Dench et al., 2000:40; Griesel & Parker, 2009:16; Pool & Sewell, 2007:280; refer to 2.3.4.5 l and Table 2.2) and included into the survey. Therefore, this subsection of the survey (see Annexure F, item 4.16) presented the participants with four questions probing applied food science and technology competencies, as shown in Table 4.20.

Table 4.20: Food science and technology: Questions and percentage of ‘high importance’ responses

<table>
<thead>
<tr>
<th>Applied food science and technology</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Apply and incorporate the principles of food science in practical, real-world situations and problems.</td>
<td>90,6</td>
<td>85,5</td>
</tr>
<tr>
<td>Q2: Select and compile experimental designs and apply statistical principles to food science and technology applications.</td>
<td>70,3</td>
<td>61,8</td>
</tr>
<tr>
<td>Q3: Interpret statistical analysis of data and recommend appropriate action.</td>
<td>71,9</td>
<td>69,1</td>
</tr>
<tr>
<td>Q4: Replace existing ingredients within a food formulation to, for example, cut costs or improve quality.</td>
<td>81,3</td>
<td>87,3</td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance*

As can be seen from Table 4.20, the ability to apply and incorporate the principles of food science and technology in practical, real-world situations and problems was identified as essential by both ‘Food Scientist’ and ‘Food Technologist’ participants. This was supported by a Food Scientist participant who observed that the ability to apply food science and technology was “very important” and observed that “it helps
you with problem solving and logical thinking which is extremely important from a technical and financial view". Likewise, the ability to replace ingredients in a food formulation to achieve certain objectives was perceived as essential and was used to verify the findings of one of the questions in the food product development subsection see 4.4.4.11).

No additional applied food science and technology knowledge, skills and competencies were identified from the analysis of the open-ended responses that were not already probed in the survey items. Based on the findings, the challenge of developing and enhancing the application of food science and technology knowledge, skills and competencies in the context of the food, beverage and allied industries workplace environment was identified (see Table 4.20, question 1).

4.3.4.14 Summary: Fundamental food science and technology knowledge, skills and competencies

The findings of this section are summarised in Table 4.21. The summary of perceived required food science and technology skills identified through the findings informed the formulation of the challenges which needed to be addressed through educational strategies.

Table 4.21 shows that the ‘Food Technologist’ career category participants perceived more of the survey questions presented as essential in terms of the criteria adopted for this study than the ‘Food Scientist’ participants. However, scrutiny of the findings indicates that there is little difference in the fundamental food science and technology knowledge, skills and competencies identified by the ‘Food Scientists’ and ‘Food Technology’ participants. The findings support that similar core discipline-specific knowledge, skills and competencies are expected from food scientists and food technologists when they graduate to effectively perform in the workplace.
| **Table 4.21:** Summarising the findings: Fundamental food science and technology knowledge skills and competencies |
| :--- | :--- | :--- |
| **Food analysis:** analytical, biochemical and chemical (refer to Table 4.8)  
(IFT, 2019:6; FC 4-8)* | Not identified as essential in terms of the criteria used in this study | Q7: Determine the quality aspects (other than microbiological) to determine the shelf-life of products |
| Q8: Construct a food analysis report recording results of food analysis, interpretation of the results and conclusion/s. | Q8: Construct a food analysis report recording results of food analysis, interpretation of the results and conclusion/s. |
| Q9: Interpret a food analysis report and take appropriate action. | Q9: Interpret a food analysis report and take appropriate action. |
| **Food analysis:** microbiological* (refer to Table 4.9)  
(IFT, 2019:6; FM 3 & 6)* | None identified as essential in terms of the criteria used in this study | Q5: Construct a food microbial analysis report to record results of analysis, interpret results and draw conclusions |
| **Sensory analysis** (refer to Table 4.10)  
(IFT, 2019:7; SS)* | None identified as essential in terms of the criteria used in this study | Q3: Make use of Good Sensory Laboratory Practices when conducting sensory analysis |
| **Food chemistry*** (refer to Table 4.11)  
(IFT, 2019:6; FC 1-3)* |  
Q1: Identify the functional properties of food components within foods and select food ingredients to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life). |  
Q1: Identify the functional properties of food components within foods and select food ingredients to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life). |
| Q2: Describe the structure and apply the chemistry of food components to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life) during processing, storage, distribution and sale. | Q2: Describe the structure and apply the chemistry of food components to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life) during processing, storage, distribution and sale. |
| Q3: Apply knowledge to interpret results from food analysis in order to measure, control, modify and improve the required product attributes. | Q3: Apply knowledge to interpret results from food analysis in order to measure, control, modify and improve the required product attributes. |
| **Nutrition** (refer to Table 4.12) |  
Q4: Understand and apply knowledge of food allergies in all areas of food manufacture from product development and selection of ingredients through production, packaging and labelling. (IFT, 2019:6; FS 1-3)* |  
Q4: Understand and apply knowledge of food allergies in all areas of food manufacture from product development and selection of ingredients through production, packaging and labelling. (IFT, 2019:6; FS 1-3)* |
| Q7: Understand and apply nutrition principles to food product development and food formulation and develop a correct nutritional table to appear on a product label. | Q7: Understand and apply nutrition principles to food product development and food formulation and develop a correct nutritional table to appear on a product label. |
| **Food regulation and control, including legislation** (refer to Table 4.13) |  
Q3: Demonstrate understanding of food regulation and control in the Republic of South Africa (SA) and locate, interpret and apply relevant SA legislation that regulates the safety and quality of agricultural, food and beverage products |  
Q3: Demonstrate understanding of food regulation and control in the Republic of South Africa (SA) and locate, interpret and apply relevant SA legislation that regulates the safety and quality of agricultural, food and beverage products |
<table>
<thead>
<tr>
<th></th>
<th><strong>Food Scientists</strong></th>
<th><strong>Food Technologists</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>from product and formulation development through manufacturing, packaging, labelling, distribution and sale.</td>
<td>from product and formulation development through manufacturing, packaging, labelling, distribution and sale.</td>
</tr>
<tr>
<td><strong>Q4:</strong></td>
<td>Critique a food product label against the SA legislative requirements and/or develop a food label that meets the requirements of SA legislation.</td>
<td>Q4: Critique a food product label against the SA legislative requirements and/or develop a food label that meets the requirements of SA legislation.</td>
</tr>
<tr>
<td></td>
<td>Not identified as essential in terms of the criteria used in this study</td>
<td>Q1: Classify and describe micro-organisms including those that can be used to produce fermented foods, influence microbial safety (i.e. pathogens causing foodborne illness) and quality in foods (i.e. spoilage organisms)</td>
</tr>
<tr>
<td><strong>Q2:</strong></td>
<td>Demonstrate learning of the role and significance of intrinsic (pH, aw, nutrients, etc.) and environmental/extrinsic parameters (temperature of storage, atmosphere of storage, etc.) and apply this knowledge to promote microbial growth (e.g. fermented foods, destroy micro-organisms and/or inhibit microbial growth).</td>
<td>Q2: Demonstrate learning of the role and significance of intrinsic (pH, aw, nutrients, etc.) and environmental/extrinsic parameters (temperature of storage, atmosphere of storage, etc.) and apply this knowledge to promote microbial growth (e.g. fermented foods, destroy micro-organisms and/or inhibit microbial growth).</td>
</tr>
<tr>
<td><strong>Q3:</strong></td>
<td>Understand the factors that lead to foodborne illness and implement strategies and systems to prevent/limit the incidence of foodborne illness.</td>
<td>Q3: Understand the factors that lead to foodborne illness and implement strategies and systems to prevent/limit the incidence of foodborne illness.</td>
</tr>
<tr>
<td><strong>Q4:</strong></td>
<td>Manipulate parameters and apply microbial and processing knowledge of food preservation techniques such as pasteurisation, heat sterilisation, irradiation, freezing, etc. to ensure the microbial stability and safety of foods and related products.</td>
<td>Q4: Manipulate parameters and apply microbial and processing knowledge of food preservation techniques such as pasteurisation, heat sterilisation, irradiation, freezing, etc. to ensure the microbial stability and safety of foods and related products.</td>
</tr>
<tr>
<td></td>
<td>None identified as essential in terms of the criteria used in this study</td>
<td>Q5: Describe and predict the microbial spoilage patterns of foods and related products and implement strategies and systems to obtain the required shelf-life</td>
</tr>
<tr>
<td></td>
<td>None identified as essential in terms of the criteria used in this study</td>
<td>Q6: Develop microbiological criteria or specifications for raw materials and finished products</td>
</tr>
<tr>
<td></td>
<td>None identified as essential in terms of the criteria used in this study</td>
<td>Q1: Identify the basic properties and uses of various packaging materials and compare and select appropriate packaging systems to meet requirements (including product safety, quality, preservation, convenience, marketing, consumer needs, etc.).</td>
</tr>
<tr>
<td></td>
<td>Not identified as essential in terms of the criteria used in this study</td>
<td>Q1: Describe the source and variability of raw food materials and select suitable raw food materials for various food processing and preservation operators</td>
</tr>
</tbody>
</table>

**Food microbiology including general microbiology (refer to Table 4.14)**

(IFT, 2019:6; FM 1,2,4 & 5)*

**Food packaging (refer to Table 4.15)**

(IFT, 2019:7; FE 7)*

**Food processing (refer to Table 4.16)**
<table>
<thead>
<tr>
<th>Field</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>(IFT, 2019:7; FE 3-6, 8 &amp; 9)*</td>
<td><strong>Q2:</strong> Identify the spoilage and deterioration mechanisms in foods and apply the food processing and preservation principles to increase shelf-life, retain sensory, quality and nutritional properties and produce safe food products.</td>
<td><strong>Q2:</strong> Identify the spoilage and deterioration mechanisms in foods and apply the food processing and preservation principles to increase shelf-life, retain sensory, quality and nutritional properties and produce safe food products.</td>
</tr>
<tr>
<td></td>
<td><strong>Q5:</strong> Determine the effects of processing parameters on product safety and quality.</td>
<td><strong>Q5:</strong> Determine the effects of processing parameters on product safety and quality.</td>
</tr>
<tr>
<td>Food engineering (refer to Table 4.17)</td>
<td>None identified as essential in terms of the criteria used in this study.</td>
<td>None identified as essential in terms of the criteria used in this study.</td>
</tr>
<tr>
<td>(IFT, 2019:7; FE 1 &amp; 2)*</td>
<td><strong>Q1:</strong> Research current trends and new ingredients, process technologies and packaging to develop new product concepts and prototypes and/or improve existing products.</td>
<td><strong>Q5:</strong> Determine the effects of processing parameters on product safety and quality.</td>
</tr>
<tr>
<td></td>
<td><strong>Q2:</strong> Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
<td><strong>Q3:</strong> Develop, implement and evaluate existing Prerequisite Programmes (PRPs) (e.g. pest control, personal hygiene, cleaning and sanitation, etc.) within the food and related industries.</td>
</tr>
<tr>
<td></td>
<td><strong>Q6:</strong> Design safety and quality into new or existing food products through raw material/ingredient selection, process flow development, determining the process parameters, packaging, etc.</td>
<td><strong>Q6:</strong> Design safety and quality into new or existing food products through raw material/ingredient selection, process flow development, determining the process parameters, packaging, etc.</td>
</tr>
<tr>
<td></td>
<td>Not identified as essential in terms of the criteria used in this study.</td>
<td><strong>Q7:</strong> Determine the shelf-life of product prototypes during the development process.</td>
</tr>
<tr>
<td>Food product development (refer to Table 4.18)</td>
<td><strong>Q1:</strong> Develop and apply Food Safety Objectives to ensure food safety and quality.</td>
<td><strong>Q1:</strong> Develop and apply Food Safety Objectives to ensure food safety and quality.</td>
</tr>
<tr>
<td></td>
<td><strong>Q2:</strong> Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
<td><strong>Q2:</strong> Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
</tr>
<tr>
<td></td>
<td><strong>Q3:</strong> Develop, implement and evaluate existing Prerequisite Programmes (PRPs) (e.g. pest control, personal hygiene, cleaning and sanitation, etc.) within the food and related industries.</td>
<td><strong>Q3:</strong> Develop, implement and evaluate existing Prerequisite Programmes (PRPs) (e.g. pest control, personal hygiene, cleaning and sanitation, etc.) within the food and related industries.</td>
</tr>
<tr>
<td></td>
<td>None identified as essential in terms of the criteria used in this study.</td>
<td><strong>Q4:</strong> Understand and apply knowledge when planning and/or evaluating food processing plant location, building structures, services (water, air, steam, etc.) and materials of construction and apply principles of food safety and quality to...</td>
</tr>
<tr>
<td>Food safety and quality management (refer to Table 4.19)</td>
<td><strong>Q1:</strong> Develop and apply Food Safety Objectives to ensure food safety and quality.</td>
<td><strong>Q1:</strong> Develop and apply Food Safety Objectives to ensure food safety and quality.</td>
</tr>
<tr>
<td>(IFT, 2019:6-7; FS &amp; QA)*</td>
<td><strong>Q2:</strong> Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
<td><strong>Q2:</strong> Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.</td>
</tr>
<tr>
<td></td>
<td><strong>Q3:</strong> Develop, implement and evaluate existing Prerequisite Programmes (PRPs) (e.g. pest control, personal hygiene, cleaning and sanitation, etc.) within the food and related industries.</td>
<td><strong>Q3:</strong> Develop, implement and evaluate existing Prerequisite Programmes (PRPs) (e.g. pest control, personal hygiene, cleaning and sanitation, etc.) within the food and related industries.</td>
</tr>
<tr>
<td></td>
<td>None identified as essential in terms of the criteria used in this study.</td>
<td><strong>Q4:</strong> Understand and apply knowledge when planning and/or evaluating food processing plant location, building structures, services (water, air, steam, etc.) and materials of construction and apply principles of food safety and quality to...</td>
</tr>
<tr>
<td>Food Scientists</td>
<td>Food Technologists</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the layout, flow and area zoning within the food processing facility</td>
<td></td>
</tr>
</tbody>
</table>

* Denotes overlap with the Institute of Food Technologists' ‘Core Competencies in Food Science” (IFT, 2019:6-8)
To answer the second research sub-question, the findings summarised in Table 4.21 were compared to the educational requirements and guidelines for undergraduate food science and technology programmes identified through literature (refer to Table 2.2). A considerable degree of overlap between the findings of this study and the core knowledge, skills and competencies identified globally was observed. When compared to the minimum educational requirements for approval of undergraduate qualifications by the IFT (2019:6-8), there was general agreement regarding the minimum core food science and technology knowledge, skills and competencies. It was concluded that the “Core Competencies for Food Science” (IFT, 2019:6-8) that are the minimum requirements for approval of undergraduate programmes by the IFT could be used as a guideline for the learning outcomes of South African food science and technology programmes. However, this situation analysis identified additional knowledge areas which should be addressed in South African food science and technology programmes, including nutrition, food product development and food packaging.

4.4.5 Food and allied industry subsectors

The food and allied sector comprise subsectors that operate in different areas and that may need skills that are subsector-specific (Expert Group on Future Skills Needs, 2009:6; Ho et al., 2011:9-11; Igumbor et al., 2012:2). In food science and technology education it is important to ensure that generic graduate attributes and fundamental discipline-specific knowledge, skills and competencies can be applied appropriately in the various subsectors. To identify the relative importance of the subsectors of the South African food and allied sector, the survey participants were presented with a list of subsectors identified through a literature review as relevant to this study. They were asked to rate the perceived importance of each of the provided subsectors according to a pre-determined six-point Likert-type rating scale (refer to Table 4.2). The subsectors provided and the percentage of ‘high importance’ responses for each are reported in Table 4.22.
Table 4.22: Food and allied industry subsectors and percentage of ‘high importance responses’

<table>
<thead>
<tr>
<th>Food and allied industry subsectors</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% High Importance</td>
<td>% High Importance</td>
</tr>
<tr>
<td>Q1: Fresh and processed meat products.</td>
<td>75,0</td>
<td>81,8</td>
</tr>
<tr>
<td>Q2: Fresh and processed poultry products.</td>
<td>79,4</td>
<td>81,8</td>
</tr>
<tr>
<td>Q3: Fresh and processed fish and fish products.</td>
<td>73,4</td>
<td>81,8</td>
</tr>
<tr>
<td>Q4: Fresh and processed fruit and vegetables.</td>
<td>71,9</td>
<td>71,7</td>
</tr>
<tr>
<td>Q5: Vegetables and animal fats and oils.</td>
<td>74,2</td>
<td>69,1</td>
</tr>
<tr>
<td>Q6: Milk and milk products (e.g. pasteurised and UHT milk, milk powders, concentrated milk products).</td>
<td><strong>87,5</strong></td>
<td><strong>89,1</strong></td>
</tr>
<tr>
<td>Q7: Dairy products (e.g. butter, hard cheeses, soft cheeses, yoghurt, ice-creams).</td>
<td>78,1</td>
<td>87,3</td>
</tr>
<tr>
<td>Q8: Grain mill products.</td>
<td>67,2</td>
<td>74,5</td>
</tr>
<tr>
<td>Q9: Starches and starch products.</td>
<td>67,2</td>
<td>76,4</td>
</tr>
<tr>
<td>Q10: Prepared animal feeds.</td>
<td>29,7</td>
<td>40,0</td>
</tr>
<tr>
<td>Q11: Baked wheat flour products, including baked bread, confectionery and snacks (e.g. pretzels).</td>
<td>70,3</td>
<td>69,1</td>
</tr>
<tr>
<td>Q12: Sugar and sugar confectionery.</td>
<td>53,1</td>
<td>65,5</td>
</tr>
<tr>
<td>Q13: Cocoa and chocolate manufacture.</td>
<td>47,6</td>
<td>56,4</td>
</tr>
<tr>
<td>Q14: Pasta, couscous and similar products.</td>
<td>44,4</td>
<td>52,7</td>
</tr>
<tr>
<td>Q15: Snack products other than baked wheat flour snacks.</td>
<td>56,3</td>
<td>61,8</td>
</tr>
<tr>
<td>Q16: Tea, coffee and hot beverages such as hot chocolate.</td>
<td>42,2</td>
<td>53,7</td>
</tr>
<tr>
<td>Q17: Distilled spirit products and liqueurs.</td>
<td>42,2</td>
<td>58,2</td>
</tr>
<tr>
<td>Q18: Wine products.</td>
<td>50,0</td>
<td>56,4</td>
</tr>
<tr>
<td>Q19: Malt, malt liquors and malt beers.</td>
<td>54,0</td>
<td>55,6</td>
</tr>
<tr>
<td>Q20: Soft drinks and mineral water (both carbonated and still).</td>
<td>53,1</td>
<td>70,4</td>
</tr>
</tbody>
</table>

*Bold* and shaded indicates 80% or above response rates for perceived high importance.

According to Table 4.22, the ‘Food Scientist’ career category participants only perceived subsector-specific professional understanding, skills and competencies in the milk and milk products subsector as essential. In contrast, the ‘Food Technology’ career category participants identified the following as essential subsectors:

- Fresh and processed meat products
- Fresh and processed poultry products
- Fresh and processed fish and fish products
• Milk and milk products
• Dairy products

Analysis of the open-ended responses to the request for general comments related to broad sector-specific professional knowledge, skills, and competencies identified that participants supported the notion that **broad, fundamental food science and technology knowledge, skills and competencies were more important than in-depth sector-specific knowledge, skills and competencies for graduates entering the profession for the first time.** One participant summarised this sentiment as follows: **“A broad understanding of all the above [sectors] is needed, once the graduate is in the work place a more specialised understanding of the field they are working in would come with experience”** [Food Scientist].

Another participant observed that **“It is not realistic to expect a newly qualified food scientist/technologist to have an in-depth knowledge of the specific category [of food product] in which he/she is to be working as much of this will be obtained ‘on the job’”** [Food Scientist].

### 4.5 WORK-INTEGRATED LEARNING AND WORK PLACEMENT

The term ‘work-integrated learning’ has been adopted to describe the curricular, pedagogic and assessment practices that integrate academic learning with learning that is “more situated, participative, and ‘real world’ oriented” (SA CHE, 2011:4). Work-integrated learning approaches aim to integrate theoretical knowledge gained at higher education institutions with practice, and can go beyond work placements (Kruger, 2014:160; SA CHE, 2011:4; SA DHET, 2012b:11; Ryan, Toohey & Hughes, 1996:355; Tran, 2016:62). The contribution of work-integrated learning approaches to facilitate the development of generic graduate attributes associated with employability, graduateness and social responsibility is well documented (LeGrand et al., 2017:118; Lowden et al., 2011:vii; Pillai et al., 2012:189; Shen, Buskes, Evan & Ooi, 2011; Tran, 2016:62; Tymon, 2013:445; Wilton, 2012:603; Yorke, 2006:2).
Within South Africa, work-integrated learning is typically incorporated in vocational and professionally-oriented qualifications, although it can be part of all qualification types (SA DHET, 2012b:11). As such, work-integrated learning has been incorporated into the curricula of food technology educational programmes as a period of work placement, but may not be part of food science educational programmes. This is related to the requirement that the National Diploma: Food Technology that has been offered at South African higher education institutions since May 2003, required 360 credits over three years of which 30 percent, or one year, was ‘experiential time’ or work placement (SA DOE, 2004:316). Although York (2006:2) suggests that some employability skills can only be developed within the context of employment, there has been growing pressure from within South African higher education institutions to reduce and/or eliminate the periods of workplace learning from vocational food technology programmes and/or to replace vocation diplomas with degrees containing increased scientific content (Garraway, 2013:3). An illustration of this is that the curriculum of the vocationally-oriented degree programme in applied food science and technology introduced in January 2018 at the Durban University of Technology (DUT) excludes the period of work-integrated learning (DUT, 2018:16).

During the focus group discussions to confirm and streamline the content of the questionnaire (refer to 3.3.3.2), the role of work placement was discussed. The sentiment expressed by the participants indicated that a period of work placement was a valuable element of the curriculum in the food technology qualifications and should be retained. In addition, the general feeling during the focus group discussions was that the introduction of a period of work placement in degree studies in food science offered at traditional academic universities should be considered. Based on the outcomes of the focus group discussions, it was decided to include questions at the end of the survey to measure the perceived usefulness of a period of work-integrated learning or work placement in developing the necessary graduate capabilities of food scientists and technologists. Table 4.23 summarises the participants’ responses to the usefulness of work-integrated learning.
Table 4.23: Usefulness of work-integrated learning

<table>
<thead>
<tr>
<th>Response</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Essential/Very important</td>
<td>88,5</td>
<td>92,7</td>
</tr>
<tr>
<td>Undecided</td>
<td>6,6</td>
<td>1,8</td>
</tr>
<tr>
<td>Not at all useful</td>
<td>4,9</td>
<td>5,5</td>
</tr>
<tr>
<td>Total</td>
<td>100,0</td>
<td>100,0</td>
</tr>
</tbody>
</table>

*Bold and shaded indicates 80% or above response rates for perceived high importance*

Examining the results show that participants of both the ‘Food Science’ and ‘Food Technology’ career categories perceived work-integrated learning as essential or very important in developing the required graduate capabilities of both food scientists and food technologists. This finding indicates that the survey participants support that a period of work placement be included in the curriculum of all qualification types in food science and technology. Participants were also asked to indicate a suggested period of work placement that must be included in the curriculum of food science and technology qualifications should work-integrated learning continue/or be introduced into the curriculum. The following information was obtained:

Table 4.24: Average period (months) of work-integrated learning

<table>
<thead>
<tr>
<th>Period (in months)</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>7,20</td>
<td>10,83</td>
</tr>
</tbody>
</table>

These findings reveal that participants support a rather extensive period of work-integrated learning before students can graduate as either a food scientist or a food technologist. This implies that rather than reducing or eliminating work placements, a period of work-integrated learning could be considered for inclusion in the curricula of all food science and technology qualifications.

The participants were also asked to provide comments on the perceived skills acquired or enhanced during periods of work placement. These comments were thematically coded by placing them into two categories, namely the identified necessary generic graduate attributes (refer to Table 4.5) and personal attributes (refer to Table 4.7), and
applied food science and technology knowledge, skills and competencies (refer to Table 4.20). The findings are reported in Table 4.25.

**Table 4.25: Skills and competencies developed during work placement**

<table>
<thead>
<tr>
<th>Employment experience (minimum of one year)</th>
<th>Career category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food Scientists</td>
</tr>
<tr>
<td>Generic graduate attributes &amp; personal attributes</td>
<td>46,9</td>
</tr>
<tr>
<td>Applied food science and technology skills &amp; competencies</td>
<td>53,1</td>
</tr>
</tbody>
</table>

The findings reported in Table 4.25 show that the ‘Food Scientist’ participants who provided comments felt that students develop and enhance both generic graduate attribute skills, as well as applied food science and technology skills and competencies in nearly equal proportions. In contrast, the ‘Food Technology’ career category participants perceived that work placements develop and enhance generic graduate attributes more highly than applied food science and technology skills and competencies. When thematically analysing the comments by looking for the themes that occurred in each comment, the following was seen: All the themes from the comments were identified as essential generic graduate and personal attributes in terms of this study, apart from interpersonal skills (see Table 4.6, question 9).

Table 4.26 shows that time and self-management skills and teamwork were perceived as the most important generic graduate attributes that can be enhanced through work-integrated learning. In addition, eagerness or willingness to learn (refer to Table 4.6, question 13) was identified as a personal attribute that is perceived to be enhanced during work-integrated learning.
Table 4.26: Generic graduate and personal attributes identified from the comments of ‘All’ participants

<table>
<thead>
<tr>
<th>Generic graduate attributes subsections</th>
<th>Identified essential generic graduate attributes</th>
<th>Number of times included in a comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>General employability skills (refer to Figure 4.2)</td>
<td>Computer literacy skills</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Organisational skills</td>
<td>2</td>
</tr>
<tr>
<td>Communication skills: Written (refer to Figure 4.5)</td>
<td>Recording and reporting</td>
<td>3</td>
</tr>
<tr>
<td>Communication skills: Written &amp; verbal (refer to Figures 4.5 &amp; 4.6)</td>
<td>General communication skills</td>
<td>8</td>
</tr>
<tr>
<td>Leadership and management skills (refer to Figure 4.7 &amp; Table 4.4)</td>
<td>Time and self-management skills</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Critical thinking skills</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Problem-solving skills</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Decision-making skills</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Teamwork</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Adaptability and flexibility</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Project planning skills</td>
<td>3</td>
</tr>
<tr>
<td>Personal attributes (refer to Tables 4.6 &amp; 4.7)</td>
<td>Eagerness/willingness to learn</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Interpersonal skills*</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Professionalism</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Responsible x 2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Self-confidence</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Work ethics</td>
<td></td>
</tr>
</tbody>
</table>

* Not identified as an essential graduate or personal attribute in terms of this study

A Food Scientist participant observed that the benefits of work placement, included improving “general people skills, work ethic and professionalism, leadership and decision making”. Another participant stated that “one learns professionalism, confidence [emphasis added] and to apply theory to practical situation” [Food Scientist]. A Food Technologist participant stated that “most valuable is the confidence [emphasis added] instilled and broad understanding of a food manufacturing organisation”. The development of self-confidence was considered a major benefit of workplace learning by six participants; a view supported by Balta et al. (2012:399).

The ability to integrate and apply food science and technology theoretical knowledge in the workplace was identified as the foremost discipline-specific benefit to students. This was captured by “application of theory in a real environment, having to make-do with what’s there because industry doesn’t have all the latest and greatest. Learning from experienced people, knowledge transfer” [Food Scientist]. Another Food
Scientists participant wrote: “Appreciation of the diversity of the Food Industry, but also to place their academic knowledge into better perspective… This cannot be attained to the same extent in the academic (study) environment”.

In addition, the experience of workplace dynamics was identified as a benefit of work placement as capture by comments such as “holistic awareness of the different parts of a business and how they integrate” [Food Scientist], and “…real world knowledge of work place dynamics” [Food Technologist].

The findings show that periods of work-integrated learning as work placement could have many benefits for the student and is perceived to play a positive role in developing generic graduate attributes, personal attributes, as well as allowing students to make the connection between theory and practice. However, work-integrated learning is not currently included in the programme structure of all existing food science and technology undergraduate qualifications and other educational strategies that mimic the benefits of work placement need to be investigated. Therefore, the role of experiential learning to develop and enhance the perceived necessary graduate capabilities of food scientists and technologists will be further described as an educational strategy in Chapter Six.

4.6 SUMMARY OF MAIN FINDINGS

The aim of conducting the situation analysis was to identify the essential graduate capabilities, as perceived by relevant stakeholders, that are required for students to ‘become’ effective and competent food scientists and technologists. The graduate capabilities investigated included:

- generic graduate attributes, including the associated concepts of employability, graduateness and civil responsibility;
- the preferred and needed personal attributes; and
- the scientific and technological knowledge, skills and competencies needed by food scientists and technologists.
A summary of the findings of each section and subsection of the survey has been provided at the end of each section or subsection. This information can be used to either renew or evaluate the content and learning outcomes of existing food science and technology qualifications. Another possibility is to develop a generic core curriculum map for food science and technology undergraduate qualifications relevant to the South African context. This approach could use the perceived necessary generic graduate attributes and associated concepts, the desirable personal attributes and the required food science and technology knowledge, skills and competencies that were identified in this study as a point of departure (Oliver, Ferns, Whelan & Lilly, 2010:80). However, the curriculum and programme learning outcomes should not be subjective or static, but must rather be fluid and adaptable to meet the continually changing needs of societal stakeholders and the specific discipline (Johnston et al., 2014:13, 17).

Consequently, it is suggested that academic staff are empowered to implement strategies to continually ensure relevance and currency of the food science and technology curriculum and programme learning outcomes, through continuous stakeholder engagement. A cyclic mechanism for continual re-evaluation and adjustment of the programme learning outcomes should be considered for implementation (Oliver, 2011:2). According to Yorke (2006:7), approaches such as curriculum mapping may facilitate the development of the required graduate capabilities but does not guarantee that they will be developed to the extent required of graduates to be effective after graduating. Attention must also be given to develop and enhance the appropriate teaching and learning pedagogies and assessment practices (Yorke, 2006:7) of the academics teaching food science and technology students. Work-integrated learning was identified as a useful strategy to develop and enhance the perceived necessary graduate capabilities of food science and technology students and should be considered for inclusion into all food science and technology curricula. If this is impractical, other educational strategies that imitate the benefits of work-integrated learning should be considered for implementation.

Comparison of the international food science and technology educational guidelines sourced through literature (refer to Table 2.2) with the findings shows that there is general agreement between the findings of this study and the generic graduate
attributes and fundamental disciplinary-specific content identified globally as essential in undergraduate food science and technology qualifications. This finding answers the second research sub-question, namely:

### Sub-question 2:
To what extent are the international food science and technology educational requirements and guidelines identified through literature applicable in the South African context?

Thus, implementation and approval against available international guidelines such as the “Core Competencies for Food Science” (IFT, 2019:6-8) will encourage globalisation and international recognition of South African food science and technology educational programmes while still meeting the expectations of South African stakeholders.

### 4.7 CONCLUDING REMARKS AND THE IDENTIFIED CHALLENGES TO BE ADDRESSED

Based on the premise that newly graduated food science and technology students do not currently meet the expectations of societal stakeholders, a situation analysis was conducted to identify the perceived graduate capabilities required from food scientists and technologists to meet the expectations of stakeholders when they first take up employment after graduating. The findings of this situation analysis allowed challenges to be formulated which formed the basis for developing educational strategies to assist academic staff in enhancing the content and teaching and learning practices of the modules they teach.

A first and important finding was that the perceived graduate capabilities that are required from food scientists and food technologists are comparable. Consequently, the overarching challenge is to ensure that future graduates from both educational backgrounds will demonstrate similar or comparable graduate capabilities aligned with the findings of this study.
Furthermore, the findings reported in this chapter sanction that the standards and essential learning outcomes of the internationally available educational guidelines of the IFT (2019:6-8) could be used as a basis for informing the learning outcomes of undergraduate South African food science and technology qualifications. Each South African institution of higher education offering a food science and/or technology programme has a unique existing curriculum for their undergraduate programme/s. The curriculum in this context refers to the institutional documented structure of the qualification requirements (Barnett & Coate, 2005:24; Annala & Mäkinen, 2012:292) that indicates subjects/modules as units, shows the sequence and progression of these units, and how they ‘fit together’ in the programme structure (Hoadley & Jansen, 2009:171). The curriculum serves in facilitating students to achieve the stated learning outcomes of the qualification as registered with the South African Qualifications Authority but allows the institution the flexibility to decide how the learning outcomes will be achieved. Academic staff teaching within the food science and technology programmes usually have the prerogative to develop the content and the teaching and learning approaches to embed the ‘core’ learning outcomes of the programme within the module/s they teach. However, the possibility exists that academic staff do this in isolation based on their subject matter expertise rather than in collaboration with the other academics teaching within the programme or with the stakeholders who will eventually employ the graduates. Consequently, the learning outcomes may not necessarily mirror the varied and seemingly ever-changing expectations of stakeholders, or capture new knowledge, skills and competencies within the discipline.

An engaging learning environment will enable students from different educational backgrounds to develop a shared professional identity and to demonstrate the perceived necessary graduate capabilities identified in this study, and in so doing, meet the expectations of societal stakeholders. Therefore, a challenge is to facilitate the academic staff to implement an engaged learning environment, including approaches to incorporate the continued relevance of the programme content and learning outcomes and the implementation of appropriate teaching and learning approaches.
Consideration of the findings also highlighted several potential areas of concern or improvement which could possibly be addressed through this study. An overview of these identified challenges is described next.

### 4.7.1 Challenges associated with specific aspects of the required graduate capabilities of food scientists and technologists

The findings indicated that the required graduate capabilities that food science and technology students should demonstrate when they graduate must include:

- capabilities associated with demonstrating the essential ‘generic’ graduate attributes, including employability skills and characteristics of graduateness;
- desirable personal attributes; and
- food science and technology discipline-specific knowledge, skills and competencies.

#### 4.7.1.1 Generic graduate attributes

An analysis of the findings reveals that the perceived required generic graduate attributes can be clustered into:

- General employability skills
- Communication skills
- Leadership, management and organisational skills
- Diversity management skills
- Entrepreneurial skills

**a) General employability skills**

The employability skills required of food science and technology graduates are: Effective reading; numeracy and mathematical skills; computer literacy; information retrieval skills; and organisational skills. Literature supports that generic graduate attributes, including general employability skills, are best enhanced in the context of
the discipline. Some of the survey participants cautioned that the essential employability skills were not necessarily being enhanced within the context of the food science and technology environment. Therefore, the need to support the development, enhancement and contextualisation of the perceived necessary employability skills specifically within the food science and technology environment, is identified as a challenge.

In addition, two of the employability skills established through the findings as essential for food science and technology graduates, namely computer literacy and information retrieval, can be clustered to form ‘digital technology skills and digital literacy’. The findings of the situation analysis supported that there is a need to enhance the digital technology skills and digital literacy ability of future graduates to meet the needs of the food, beverage and allied industries. Therefore, based on the findings the development of digital technology skills and digital literacy within food science and technology undergraduate programmes was identified as a challenge.

b) Communication skills

Communication skills, including reading, written and verbal skills, were identified as essential to food scientists and technologists. The predominant language in which communication skills are needed was identified as English. However, within the South African environment, English is not necessarily the first language of communication of students. The findings also highlighted that in general the communication skills of current graduates were not meeting the surveyed participants’ expectations, and communication was not always appropriate to the situation or context of the food science and technology work environment. Therefore, improving the general communication skills of food science and technology students using English as the medium of communication, was identified as a challenge that needs to be addressed.
c) **Leadership, management and organisational skills**

The situation analysis identified the required leadership and management skills as time- and self-management, critical thinking, problem-solving, decision-making, team work, adaptability and flexibility, and project planning and delegating. Many of these skills overlap with organisational skills identified as an employability skill. The analysis of the open-ended responses provided by the survey participants regarding the mentioned skills, indicated that the graduates currently do not have the perceived required leadership, management and organisational skills to meet stakeholders’ expectations. Subsequently, **the challenge is to develop and enhance the leadership, management and organisational skills of food science and technology students during their undergraduate studies.**

Entrepreneurial skills were not directly identified as essential to food science and technology graduates. However, within the broader South Africa environment there is a declared shortage of entrepreneurial skills and higher education is encouraged by Government to develop the entrepreneurship skills of its graduates. To have entrepreneurial skills will empower those graduates who wish to be self-employed to establish their own enterprises. Consequently, food science and technology programmes should also **address the challenge of developing the entrepreneurial skills of graduates.**

d) **Diversity management skills**

Although diversity management skills were found not to be essential to food scientists and technologists when entering the workplace for the first time, it is accepted that fundamental diversity management skills may reasonably be expected of all graduates within the South African workplace. The **challenge to develop and enhance basic diversity management skills appropriate to the context of the food science and technology workplace environment is therefore identified.**
4.7.1.2 Personal attributes

The necessary personal attributes identified through the situation analysis were clustered as: a) personal qualities, dispositions and values; b) self-management and organisational skills; and c) attributes associated with emotional intelligence. Analysis of the skills and attributes perceived to be promoted by work-integrated learning identified the enhancement of the self-esteem and self-confidence of the students. Informed by this finding and corroborated by the reported relationship between self-esteem and self-confidence to gain employment, **enhancing the self-esteem and self-confidence of students prior to work placement or employment was identified as a challenge.**

4.7.2 Applied food science and technology knowledge, skills and competencies

The situation analysis reaffirmed that the minimum required food science and technology discipline-specific knowledge, skills and competencies identified through the literature are likewise fundamental requirements for South African undergraduate food science and technology qualifications. However, the findings highlighted the need to enhance the application of the acquired food science and technology knowledge, skills and competencies within the ‘real world’ context of the food, beverage and allied industries. Therefore, **the application and integration of the food science and technology knowledge, skills and competencies gained across the different modules of the programme is identified as a challenge.**

4.7.3 Summarising the identified challenges

The overarching challenge identified in this study is to enhance the perceived required graduate capabilities identified through the situation analysis of this study, regardless of the educational background of the student. To successfully facilitate the overarching challenge and the associated challenges will require proactive action by the academic staff involved in food science and technology education to enhance the learning of
their students in the future. A summary of the challenges for academic staff which need to be addressed through a process of facilitation are summarised in Table 4.27.

### Table 4.27: Summary of the challenges or themes identified through the situation analysis

<table>
<thead>
<tr>
<th>FINDING</th>
<th>CHALLENGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The perceived needed graduate capabilities are the same for food scientists and for food technologist</td>
<td>Developing and enhancing comparable graduate capabilities of food science and technology students from different educational backgrounds</td>
</tr>
<tr>
<td>Employment skills</td>
<td>Developing and enhancing the employability skills, including digital technology skills and digital literacy, of students appropriate to the food science and technology discipline and work environment</td>
</tr>
<tr>
<td>Communication skills</td>
<td>Enhancing the communication skills of students appropriate to the food science and technology discipline and work environment</td>
</tr>
<tr>
<td>Leadership, management and organisational skills</td>
<td>Enhancing the leadership, management and organisational skills of students appropriate to the food science and technology discipline and work environment</td>
</tr>
<tr>
<td>Entrepreneurial skills</td>
<td>Developing and enhancing the entrepreneurial skills of students appropriate to the food science and technology discipline and work environment</td>
</tr>
<tr>
<td>Diversity management skills</td>
<td>Developing and enhancing the basic diversity management skills of students appropriate to the food science and technology workplace environment</td>
</tr>
<tr>
<td>Personal attributes</td>
<td>Enhancing the personal attributes of self-esteem and self-confidence of food science and technology students</td>
</tr>
<tr>
<td>Food science and technology knowledge, skills and competencies</td>
<td>Enhancing the ability of food science and technology students to integrate and apply the multi-disciplinary knowledge, skills and competencies gained across the programme modules to solve ‘real world’ problems</td>
</tr>
</tbody>
</table>

The next chapter will describe a conceptual framework to develop a process to facilitate the academic staff to enable them to optimally facilitate food science and technology students during undergraduate studies.

### 4.8 SYNTHESIS OF CHAPTER FOUR

The purpose of this chapter was to analyse the data collected through a web-based survey and then to scrutinise the findings to identify the required graduate capabilities of food scientists and technologists. As a first step, the credentials of the survey participants were established to demonstrate that they were not only ‘representative’ of the population identified as ‘relevant’ to this study, but also that they had the educational profile, work experience and were sufficiently diverse to provide reliable and well-balanced data to be used in the further analyses. Once the credentials of
the survey participants were established, the collected data were analysed to identify the perceived necessary graduate capabilities of food scientists and technologists. Based on the findings, challenges were formulated which should be addressed to facilitate the development and enhancement of the required graduate capabilities of South African food scientists and technologists.

Chapter Five will present a conceptual framework to address the facilitation of the academic staff teaching food science and technology students to be able to address the identified challenges.
CHAPTER FIVE: A CONCEPTUAL FRAMEWORK FOR THE FACILITATION OF THE ACADEMIC STAFF TO ENABLE FOOD SCIENCE AND TECHNOLOGY GRADUATES TO ATTAIN THE NEEDED GRADUATE CAPABILITIES

Think left and think right and think low and think high. Oh, the thinks you can think up if only you try! (Dr Seuss, 1975).

5.1 INTRODUCTION

The term ‘graduate capabilities’ was adopted to describe and analyse the complex ‘mix’ of generic graduate attributes, personal attributes and the discipline-specific knowledge, skills and competencies required of newly graduated food scientists and technologists. Based on the situation analysis of the empirical phase, the main theme and associated challenges were deductively derived. The main theme is that food scientists and food technologists, despite their different educational backgrounds, should demonstrate comparable graduate capabilities to meet the expectations of societal stakeholders. To achieve this outcome, the need was identified to empower the academic staff teaching food science and technology undergraduate programmes to optimally enable students to develop the required graduate capabilities during their undergraduate studies. This chapter presents a conceptual framework to interrogate what must be done to facilitate the academic staff to have the attitudes, knowledge, skills and competencies to enable food science and technology students to demonstrate the required graduate capabilities, and to partially answer the final research sub-question namely:

**Sub-question 3:**

How can the academic staff be facilitated to have the necessary attitudes, knowledge, skills and capabilities to optimally enable undergraduate food science and technology graduates to demonstrate the required graduate capabilities?

Figure 5.1 provides an overview of the structure of the chapter.
5.2 DESCRIPTION OF THE CONCEPTUAL FRAMEWORK

The proposed conceptual framework aims to integrate and guide the procedure to facilitate the academic staff involved with teaching undergraduate food science and technology programmes. The facilitation process aims to empower the academic staff to support food science and technology students to develop and enhance the required graduate capabilities by addressing the challenges identified in the empirical phase.

The conceptual framework procedures for facilitation must encourage a willingness in the academic staff to engage with and address the challenges. In addition, the facilitation must provide new knowledge and new ways of doing that will encourage new thinking (Illeris, 2009:215), thereby empowering and supporting the academic staff to address the challenges identified through the findings. In so doing, the academic staff must develop and/or enhance the required graduate capabilities of students within the context of the existing food science and technology undergraduate programmes. To ‘facilitate’, in this context, means to help, assist or make easier, while ‘facilitation’ is the act of helping, supporting and enabling (Janse van Rensburg, Poggenpoel & Myburgh, 2015:6) the academic staff to improve or make easier what they are already doing to support students in attaining the required graduate capabilities.
The proposed conceptual framework is a graphical representation based on the practice-oriented theory of Dickoff, James and Wiedenbach (1968:423) which emphasises the role of practice to inform theory. The thinking map on which the conceptual framework is based adapts the aspects proposed by Dickoff et al. (1968:415) to develop a conceptual framework that will guide the facilitation process and engage the academic staff to address the challenges identified through the situation analysis. The thinking map (refer to Figure 5.2) and the conceptual framework (refer to Figure 5.3) consider the following aspects: the context; the agent/s; the recipient/s; the dynamics; the process, procedure or activity; the terminus; and the required outcome of the procedure to meet the aims of this study. The aspects included in the reasoning map on which the conceptual framework is based are described by Dickoff et al. (1968:415) as follows:

- **Context** – the background, environment or setting in which the study was conducted and in which the procedure will take place.
- **Agent** – the facilitator who provides guidance and who will be accountable for supporting the autonomy of the ‘recipient’ through specific actions or activities.
- **Recipient/s** – the person or stakeholders who benefit from the procedure or at whom the facilitation is aimed.
- **Dynamics** – the energy source or reason for the change, activity or procedure.
- **Process/procedure or activity** – planned approaches, techniques and/or processes to achieve a goal or outcome.
- **Terminus** – the end-point of the facilitation process.
- **Outcome** – the end-result of the facilitation process.

Ultimately, the aim of the proposed conceptual framework is to reflect what can be done or facilitated by the agent or facilitator to enhance the attitudes, knowledge, skills and competencies of the recipients or academic staff. The facilitated academic staff will be capable of accomplishing the future goal of delivering food science and technology students who will exhibit the required graduate capabilities by addressing the challenges identified through the situation analysis.
Figure 5.2: The reasoning map for the conceptual framework to facilitate the academic staff
5.2.1 Assumptions of the conceptual framework

The proposed conceptual framework was formulated based on several underlying assumptions dealing with the aspects described in the following sections.

5.2.1.1 Food scientists and food technologists require comparable graduate capabilities

Historically, South African food scientists and technologists have had different educational and training backgrounds. However, the situation analysis conducted in this study showed that food scientists and technologists need similar or comparable core graduate capabilities to meet the expectations of societal stakeholders. Therefore, the assumption is that food science and technology graduates require similar or comparable graduate capabilities to meet the expectations of stakeholders, despite their different educational backgrounds.

5.2.1.2 Communications skills

To fully and effectively communicate in the higher education environment the academic staff are assumed to demonstrate an effective level of proficiency in English as a medium of communication. However, communications skills are more than language proficiency. Therefore, it is assumed that the academic staff are willing to engage in enhancing their knowledge, skills and competencies of verbal, non-verbal and written communication. By enhancing the academic staff’s knowledge and competencies in communication skills, they will be empowered to identify and implement interventions that enhance the communication skills of students; not only to meet the expectation of stakeholders once they graduate, but also to allow students to engage meaningfully in the higher education process (Hawken, Duran & Kelly, 1991:297).
5.2.1.3 Willingness

The academic staff involved in teaching food science and technology undergraduate programmes may have varied understandings of graduate capabilities in addition to possibly not having the necessary know-how to implement a process of change to overcome the identified challenges. However, the academic staff’s willingness to be facilitated to engage meaningfully in addressing the challenges is assumed.

5.2.1.4 Stakeholder engagement

The affected stakeholders, especially employers and academic staff teaching in undergraduate food science and technology programmes, are expected to actively engage, cooperate and collaborate in the process of developing and enhancing the required graduate capabilities of students. The role of the stakeholders to provide feedback to the academic staff to ensure the relevance of the programme and module learning outcomes and to make suggestions for improvement/s, is assumed. It is also anticipated that stakeholders are willing to support learning through experience initiatives and by providing meaningful workplace learning opportunities for food science and technology students.

5.2.1.5 Learning through experience

It is assumed that implementing the teaching cycle of Kolb (1984:141), incorporating meaningful work-based experiences (Hackman & Oldham, 1976:250; Kass et al., 2011:56) and student-centred teaching and learning approaches, will contribute to addressing the challenges identified through the situation analysis. Adopting such teaching approaches may support students to achieve the required graduate capabilities.

5.2.2 The conceptual framework

Based on the thinking map captured in Figure 5.2, the conceptual framework was proposed to have several phases as illustrated in Figure 5.3.
Figure 5.3: The conceptual framework for the facilitation process of the academic staff

**CONTEXT:** South African Higher Education Sector

**AGENT**
Facilitator

**RECIPIENTS**
Academic staff teaching in food science and technology

**RELATIONSHIP PHASE**
Establishing a relationship between the facilitator and the academic staff and promoting interpersonal relationships

**WORKING PHASE**
Developing a procedure to assist academic staff to address the challenges identified in the situation analysis

**TERMINATION PHASE**
Facilitated academic staff

**OUTCOME**
Academic staff with enhanced attitudes, knowledge, skills and competencies

**CHALLENGES**
- Allow students from different educational backgrounds to demonstrate similar required graduate capabilities
- Develop and enhance the needed:
  - Generic graduate attributes
  - Personal attributes of self-esteem and self-confidence
  - Application of food science and technology knowledge, skills and competencies

**CONTEXT:** Higher Education Institutions offering Food Science and Technology Programmes

**CONTEXT:** South African Higher Education Sector
5.2.3 Aspects of the conceptual framework

The aspects of the conceptual framework include the agent, the recipients, the dynamics, the procedure, the context, and the termination and outcome (Dickoff et al., 1968:415). These will now be described in more detail.

5.2.3.1 The agent

The primary agent is the researcher or a person with a similar background or an area of expertise who will take on the role of facilitator. The agent will have the responsibility for developing and implementing the facilitation process to empower the academic staff teaching in food science and technology programmes. The facilitation process aims at enhancing the attitudes, knowledge, skills and capabilities of the academic staff to enable them to address the overarching and associated challenges. The agent will also take on the role of a mentor to the academic staff to support them through the facilitation process.

5.2.3.2 The recipients

The primary recipients in this study are the academic staff involved with food science and technology education. The academic staff who are willing to engage with the facilitation process will be empowered to have a positive attitude towards undergraduate teaching and have the necessary knowledge, skills and competencies to enhance the learning environment. Although the academic staff are acknowledged to have the necessary subject matter expertise within the discipline area in which they teach, they may have limited knowledge and experience on the concept of graduate capabilities and the associated aspects of generic graduate attributes, employability skills, graduateness and personal attributes. Therefore, the academic staff must be assisted to develop a shared understanding of the terms associated with graduate capabilities. After this is achieved, the facilitation procedure must empower the academic staff with the relevant knowledge, skills and competencies to identify approaches and implement activities to overcome the overarching and associated challenges identified through the situation analysis.
The secondary recipients of this study will be future food science and technology students. Students will interact with the facilitated academic staff who will support them to attain the required graduate capabilities, thereby making them more desirable to stakeholders, such as employers. The stakeholders identified as relevant to the context of this study will also benefit in that they will have access to ‘quality’ graduate food scientists and technologists who meet their expectations and needs.

5.2.3.3 The dynamics

The dynamics in this study are underpinned by the tension between higher education and societal stakeholders. On the one hand, societal stakeholders perceive that current graduates do not meet their needs or expectations in employment, while on the other hand higher education perceives that they deliver graduates demonstrating ‘day one’ graduate capabilities. Therefore, this study conceptualises the dynamics as challenges or themes flowing from the findings of the empirical phase of the study. The tension between higher education and societal stakeholders provides the energy to enhance the attitudes, and educational knowledge, skills and competencies of the academic staff teaching within the discipline of food science and technology. The academic staff will thus be assisted to address the challenges that were identified through the situation analysis and enhance the learning environment to enable students to attain the required graduate capabilities of food scientists and food technologists.

5.2.3.4 The procedure

The procedure refers to the planned approaches and actions to address the facilitation of the academic staff to effectively address the identified challenges recognised through the situation analysis. Therefore, this section focusses on what must be done to empower the academic staff with the desired attitudes and necessary educational knowledge, skills and competencies to address the challenges. The overarching challenge was to develop and enhance similar required graduate capabilities among food science and technology students despite their different educational backgrounds. In addition, to demonstrate comparable graduate capabilities, food science and
technology graduates should have a shared professional identity. Professional identity in the context of this study is the complex identity that a food science or technology student should develop to reflect their discipline of study and the work in which they are preparing to engage (Molinero & Pereira, 2013:1605). This study proposed that by creating an engaged learning environment, students from different educational backgrounds would be supported to develop a shared professional identity and demonstrate comparable graduate capabilities. Therefore, the process of facilitation will assist the academic staff teaching within the discipline of food science and technology to identify approaches to a) create an engaging learning environment and b) address the challenges identified through the situation analysis. The facilitation process includes a relationship building phase, a working phase and a termination phase as shown in Figure 5.4.

**Figure 5.4: Facilitation process for the enablement of the academic staff**

The working phase of the facilitation process will be achieved by conducting a workshop incorporating the procedures linked to the challenges, as depicted in Table 5.1. The schema of the proposed workshops, although not forming part of this research study, are presented.
Table 5.1: Linking the challenges to the procedure

<table>
<thead>
<tr>
<th>CHALLENGE</th>
<th>PROCEDURE</th>
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<tbody>
<tr>
<td>Developing and enhancing comparable graduate capabilities of food science and technology students from different educational backgrounds</td>
<td>Provide the academic staff with the findings of the situation analysis and the challenges that must be overcome to create food science and technology graduates who demonstrate similar required graduate capabilities. Facilitate the academic staff to identify approaches to allow students from different educational backgrounds to demonstrate similar required graduate capabilities.</td>
</tr>
<tr>
<td>Developing and enhancing the employability skills, including digital technology skills and digital literacy, of students appropriate to the food science and technology discipline and work environment</td>
<td>Facilitate the academic staff to identify approaches to develop and enhance the required employability skills, including digital technology skills and digital literacy, of students within the context of the food science and technology environment.</td>
</tr>
<tr>
<td>Enhancing the communication skills of students appropriate to the food science and technology discipline and work environment</td>
<td>Facilitate the academic staff to identify approaches to develop and enhance the required communication skills of students within the context of the food science and technology environment.</td>
</tr>
<tr>
<td>Enhancing the leadership, management and organisational skills of students appropriate to the food science and technology discipline and work environment</td>
<td>Facilitate the academic staff to identify approaches to develop and enhance the required leadership, management, and organisational skills of students within the context of the food science and technology environment.</td>
</tr>
<tr>
<td>Developing and enhancing the entrepreneurial skills of students appropriate to the food science and technology discipline and work environment</td>
<td>Facilitate the academic staff to identify approaches to develop and enhance the entrepreneurial skills of students within the context of the food science and technology environment.</td>
</tr>
<tr>
<td>Developing and enhancing the basic diversity management skills of students appropriate to the food science and technology workplace environment</td>
<td>Facilitate the academic staff to identify approaches to develop and enhance the basic diversity skills of students within the context of the food science and technology environment.</td>
</tr>
<tr>
<td>Enhancing the personal attributes of self-esteem and self-confidence of food science and technology students</td>
<td>Facilitate academic staff to identify approaches that will enhance the self-esteem and self-confidence of students.</td>
</tr>
<tr>
<td>Enhancing the ability of food science and technology students to integrate and apply the multi-disciplinary knowledge, skills and competencies gained across the programme modules to solve ‘real world’ problems</td>
<td>Facilitate academic staff to identify approaches develop and enhance the ability of students to integrate and apply the multi-disciplinary knowledge, skills and competencies gained from all the modules in a food science and technology programme to solve ‘real world’ problems in the context of the food, beverage and allied industries.</td>
</tr>
</tbody>
</table>

Each of the procedures captured in Table 5.1 will be described in more detail.
a) Facilitation to implement an engaged learning environment

Facilitation by the agent will focus on enabling the academic staff with the desired attitudes and necessary educational knowledge, skills and competencies to create a learning environment which will encourage students to engage with their own learning. The learning environment, in addition to adopting student-centred teaching and learning approaches, must also remain up-to-date and adapt to the changing needs of stakeholders. As a starting point, knowledge of graduate capabilities and the associated concepts such as generic graduate attributes, employability skills, graduateness and personal attributes as conceptualised in this study, will be shared with the academic staff to establish a common understanding. The academic staff will then be presented with the required graduate capabilities of food science and technology students identified in the empirical phase of this study.

Academic staff may have limited work experience within the food, beverage or allied environment; therefore, they may not readily identify with the workplace environment of a food scientist and technologist. To formulate learning outcomes based on the findings of this study and within the context of the workplace of food scientists and technologists, stakeholder engagement and collaboration will thus be required. Academic staff will be facilitated to identify approaches to engage stakeholders seeing that stakeholder collaboration will be a central theme for the academic staff to address the challenges proposed by this study.

As a qualification with the South African Qualifications Authority (SAQA), the existing food science and technology programmes, as with all other higher education programmes in South Africa, must comply with legislative requirements of registration. The SAQA registration records the details of the qualification, including the ‘exit level outcomes’, the ‘specified outcomes’ and the ‘associated assessment criteria’. The academic staff will be assisted to identify approaches to optimally create an engaged learning environment (Figure 5.5) to develop and enhance the required graduate capabilities of students within the structure of the existing programme/s by:
• reflecting the required graduate capabilities identified through the empirical phase of this study, and
• addressing the challenges identified through the situation analysis (refer to Table 5.1).

**Figure 5.5: Implementing an engaged learning environment**

Furthermore, the academic staff will be supported to identify approaches that can be used to continually engage with the programme content and the associated learning outcomes to ensure continued relevance to the varied and ever-changing expectations of societal stakeholders. In addition, the need for stakeholder engagement in this process will be motivated. Academic staff will be assisted to identify mechanisms that can be implemented to obtain ongoing feedback from societal stakeholders to evaluate the quality of learning that food science and technology graduates demonstrate when they first take up employment.

Food science and technology students’ exposure to a community of practice (Wenger, 2010:179) in food science and technology is central to develop comparable graduate capabilities and a shared professional identity. Learning occurs intentionally or unintentionally in a community of practice when people who have a common interest in a discipline and a passion for what they do, interact (Wenger, 2010:179). However, academics teaching within the discipline may be too few in numbers to represent a food science and technology community of practice, and may have limited
food science and technology workplace experience. Therefore, the academic staff will be assisted to identify alternative approaches and interventions that can be implemented to develop and enhance the common professional identity of food science and technology students.

The academic staff will further be assisted in identifying student-centred teaching and learning approaches, competency-based assessment approaches and approaches to integrate the acquired knowledge, skills and competencies of students by incorporating ‘real world’ experiential learning activities (see Figure 5.4). The more specific facilitations to address the challenges identified by the empirical findings are described subsequently.

b) Facilitation of the required generic graduate attributes – Employability skills

Academic staff need to be assisted in identifying ways to embed and support the development and enhancement of the required employability skills. The situation analysis identified effective reading, numeracy and mathematical skills, computer literacy, information retrieval skills and organisational skills as the specific skills expected from food scientists and technologists when they graduate. Therefore, this process of facilitation will assist academic staff in identifying student-centred teaching and learning approaches and competency-based assessment strategies that will enhance the graduates’ employability skills by taking the context of the food science and technology environment into account.

Two of the identified skills, namely computer literacy and information retrieval skills, were clustered together as ‘digital technology skills and digital literacy’. Competence in digital technology skills and digital literacy will influence not only the students’ success in higher education but also their employability skills and their ability to engage in life-long learning. Ultimately, the digital technology skills and digital literacy of food science and technology students must not only meet the expectations of stakeholders but must also support the graduates to continually enhance their knowledge, skills and competencies and remain up-to-date after graduating and being
in employment. Scrutiny of undergraduate food science and technology programmes shows that many of the programmes include digital technology skills as a stand-alone module. However, it is doubtful whether the teaching and learning of these stand-alone modules are in the context of food science and technology. Academic staff must therefore be facilitated to have the necessary knowledge, skills and competencies to identify and implement interventions to reinforce and enhance the digital technical skills and digital literacy that food science and technology students already have, within the module/s they teach.

c) Facilitation of the required generic graduate attributes – Communication skills

Communication includes the verbal, non-verbal and written communication skills that allow people to share information. Although it is assumed that students have the necessary communication skills to meaningfully participate in higher education when they first register to further their studies, this is not always the case. Higher education institutions often identify the need to facilitate general communication skills at an institutional level to support the academic success of undergraduate students. It is then anticipated that students will continually develop and contextualise the general communication skills within their discipline of study as they progress through their studies. However, this is not always achieved as the necessary communications learning outcomes may not be sufficiently embedded and reiterated across the modules in the programme.

The challenge was identified that it is necessary to enhance the required communication skills among food science and technology students. To address this challenge, academic staff will be facilitated to embed and reiterate the required communication skills within the individual modules they teach. In addition, academic staff will be provided with the necessary knowledge, skills and competencies to identify continuous competency-based assessment practices that can be implemented within the modules they teach to measure the students’ attainment of the required communications skills.
d) Facilitation of the required generic graduate attributes – Leadership, management and organisational skills

In the situation analysis certain leadership and management skills were identified as essential to food science and technology graduates to meet the expectations of societal stakeholders. Most of the identified leadership and management skills, namely teamwork, time- and self-management, critical thinking, problem-solving, decision-making, adaptability, flexibility and project planning/organisational skills, can be developed during work placement opportunities provided to students prior to graduation. This will, in turn, add to the context of the food science and technology environment. However, presently only the food technology vocation programmes make provision for a period of work-integrated learning although it seems that stakeholders support the introduction of a period of work-integrated learning into all food science and technology undergraduate programmes. This facilitation process will therefore aim to provide the academic staff with the necessary knowledge, skills and competencies to identify student-centred teaching approaches and learning activities that will enhance students’ learning of leadership, management and organisational skills. Learning activities that contextualise learning to the food, beverage and allied industries workplace, and reiterate the required skills within the individual modules, will be identified. Finally, academic staff will be assisted to identify competency-based assessment strategies to evaluate if learning has occurred.

e) Facilitation of the required generic graduate attributes – Entrepreneurial skills

The need to include entrepreneurial skills as a learning outcome was identified as important to those graduates embarking on entrepreneurial ventures rather than being dependent on finding employment. Furthermore, within the South African context, there is pressure on higher education institutions to develop entrepreneurial skills of graduates (SA DHET, 2013:122). This facilitation therefore aims to provide the academic staff with the necessary knowledge, skills and competencies to embed entrepreneurial skills within the existing food science and technology programme in which they teach. Academic staff will be supported to identify appropriate student-
centred teaching and learning approaches and learning activities that will enhance the entrepreneurial skills of students within the context of food science and technology. Furthermore, academic staff will be assisted to identify competency-based assessment strategies as evidence that students have developed the required entrepreneurial skills.

f) Facilitation of the required generic graduate attributes – Diversity management skills

The situation analysis suggests that employers should take responsibility for diversity management training within the context of their workplace environments; a sentiment which is supported through literature (Chrobot-Mason & Aramovich, 2013:660; Patrick & Kumar, 2012:1). However, all graduates of South African higher education can reasonably be expected to demonstrate basic diversity management skills when they take up employment for the first time. The identification of diversity management skills as a challenge in food science and technology education was supported by the need for higher education to enhance diversity skills within context, as the context influences the learning outcomes (Kulik & Roberson, 2008:309). The facilitation process will provide academic staff with the necessary knowledge, skills and competencies to contextualise and embed basic diversity management skills within the existing food science and technology programmes. In addition, academic staff will be assisted to identify competency-based assessment strategies to assess if the required learning is achieved; either before students are placed for work-integrated learning or before they graduate to take up employment.

g) Facilitation of the personal attributes of self-esteem and self-confidence

The challenge of enhancing students’ personal attributes of self-esteem and self-confidence, as these are linked to employability, was identified through the situation analysis. Most institutions of higher education provide students with support centres to cope with the environment and to provide services that build the self-confidence of students, as this is recognised to optimise students’ academic outcomes and improve student retention (Atherton, 2017:19 & 27). In addition, the role of interactions between
academic staff and students is proposed as invaluable to increase the students’ self-esteem and self-confidence (Komarraju, Musulkin & Bhattacharya, 2010:332). Consequently, the facilitation process will support the academic staff to identify approaches that they can use to enhance the students’ personal attributes of self-esteem and self-confidence.

**h) Facilitation of the application of the food science and technology knowledge, skills and competencies in the ‘real world’**

Although food science and technology programmes aim to integrate the discipline-specific knowledge skills and competencies gained in the various modules offered in the programme, academic staff constraints often hamper this outcome. This may result in students being unable to apply the knowledge, skills and competencies they have acquired across the curriculum modules in the context of the ‘real world’ of the food, beverage and allied industries. For this reason, facilitation will aim to empower the academic staff with the necessary knowledge, skills and competencies to implement approaches to embed and integrate the multi-disciplinary knowledge, skills and competencies gained across all the modules of the food science and technology programme/s. Furthermore, academic staff will be assisted to identify student-centred teaching and learning approaches that will allow students to apply their combined knowledge, skills and competencies within the ‘real world’ of the food science and technology workplace. The academic staff will also be supported to identify possible strategies for the continuous evaluation of students through competency-based assessment practices.

**5.2.3.5 The context**

This study was motivated by a perceived discrepancy between the graduate capabilities demonstrated by current food science and technology graduates and those graduate capabilities that societal stakeholders need and expect. Certain challenges were identified through the situation analysis; if these are addressed by the academic staff teaching within the discipline of food science and technology, it will allow future food science and technology graduates to demonstrate the required
graduate capabilities. Therefore, the context of facilitating the academic staff extends to the broader South African higher education landscape, and more specifically, the higher education institutions that offer food science and technology programmes (refer to Annexure M).

The broader context extends to the South African food, beverage and allied industries as these industries represent the ‘real world’ workplace of food science and technology graduates. The academic staff must be able to assist students in attaining the required graduate capabilities that will allow them to meet the expectations of their future employers and be successful after graduating.

5.2.3.6 The terminus and the outcome of the study

The terminus of the procedure will take place once the process of facilitation is completed and academic staff teaching food science and technology undergraduate programmes have been facilitated. The outcome will be academic staff who have sufficient knowledge, skills and competencies and who are capable of implementing educational strategies to constructively and actively address the challenges identified through the situation analysis. The academic staff will be able to facilitate future students to attain the graduate capabilities identified as required through the situation analysis to meet the expectations of stakeholders.

5.3 SYNTHESIS OF THE CHAPTER

This chapter proposed a conceptual framework to guide the facilitation of the academic staff teaching in the discipline of food science and technology. The aim is to assist the academic staff with the necessary attitudes, knowledge, skills and competencies to identify approaches to address the challenges identified through the situation analysis, by:

- creating an engaged learning environment that encourages student-centred learning and competency-based assessment; and
- addressing the challenges formulated from the empirical findings to:
o develop and enhance certain aspects of the required generic graduate attributes, including employability skills, communication skills, leadership, management and organisational skills, entrepreneurial skills and diversity management skills;

o enhance the personal attributes of self-esteem and self-confidence; and

o encourage the application of food science and technology disciplinary knowledge, skills and competencies through experiential learning approaches in the context of the ‘real world’ of the food, beverage and allied industries.

The following chapter will describe how the facilitation will be achieved.
CHAPTER SIX: THE DEVELOPMENT OF THE EDUCATIONAL STRATEGIES FOR THE FACILITATION PROCESS OF THE ACADEMIC STAFF TEACHING IN FOOD SCIENCE AND TECHNOLOGY

UNLESS someone like you cares a whole awful lot, nothing is going to get better. It’s not (Dr Seuss, 1971).

6.1 INTRODUCTION

This study conducted a situation analysis to identify the required graduate capabilities that newly graduated food scientists and technologists must demonstrate to meet the needs and expectations of societal stakeholders. Based on the findings of the situation analysis, challenges to accomplish the outcome were formulated that need to be addressed by academic staff teaching in the discipline of food science and technology. By successfully addressing these challenges, the academic staff will support food science and technology students to achieve the required graduate capabilities during their undergraduate studies. Consequently, Chapter Five proposed a conceptual framework to guide the facilitation of the academic staff and propose what must be done to assist and support the academic staff to have the necessary attitudes, knowledge, skills and capabilities to address the identified challenges. This chapter proposes how the facilitation process can be achieved. Educational strategies that show how the attitudes, knowledge, skills and competencies of academic staff can be facilitated are described. In so doing, the final research sub-question is answered, namely:

Sub-question 3:
How can the academic staff be facilitated to have the necessary attitudes, knowledge, skills and capabilities to optimally enable undergraduate food science and technology graduates to demonstrate the required graduate capabilities?

Figure 6.1 provides an overview of the structure of the chapter.
6.2 INTRODUCTION TO FORMULATING THE STRATEGIES

A strategy in the context of this study is viewed as a plan of action (Mintzberg, 1987:12, see 1.3.3.9) to assist the academic staff teaching food science and technology students. The strategy is developed to address the challenges identified in the situation analysis within the existing structure of food science and technology undergraduate programme/s in which they teach. Facilitation of the academic staff may be addressed by one or a combination of several strategies. Ultimately, the proposals in this study aim to establish future newly graduated food scientists and technologists who demonstrate the required graduate capabilities identified in the situation analysis of this study.

Foundational to the facilitation process is a collaborative and cooperative approach between the facilitator and the academic staff. The working phase will be a workshop developed and facilitated at each of the higher education institutions that offer food science and technology programmes (refer to Annexure M). The development process for the educational strategies and the associated actions for the facilitation process is summarised in Table 6.1. It is the process of ‘doing something’ to assist the academic staff in addressing the challenges identified through the situation analysis.
Table 6.1: Overview of the development process of the educational strategies

<table>
<thead>
<tr>
<th>THE INITIATION PHASE</th>
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<tbody>
<tr>
<td>STRATEGY: RELATIONSHIP BUILDING</td>
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<tr>
<td>OBJECTIVES</td>
<td></td>
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<tr>
<td>• To establish a relationship between the facilitator and the academic staff</td>
<td></td>
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<tr>
<td>• To facilitate a positive attitude and obtain commitment from the academic staff to engage with the objectives of the workshop</td>
<td></td>
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<tr>
<td>ACTIONS</td>
<td></td>
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<tr>
<td>• Establishing a relationship between the facilitator and the academic staff</td>
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<tr>
<td>o Providing the credentials of the facilitator</td>
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<tr>
<td>o Providing the background to this study</td>
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<td>o Encouraging interaction between the workshop participants</td>
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<td>o Building trust and mutual respect</td>
<td></td>
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<tr>
<td>• Facilitating a positive attitude and obtain commitment from the academic staff to engage with the objectives of the workshop</td>
<td></td>
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<tr>
<td>o Explaining the need for higher education to produce graduates who meet the expectations of societal stakeholders</td>
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<tr>
<td>o Motivating the importance of undergraduate teaching</td>
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<tr>
<td>o Establishing the goals and objectives of the workshop</td>
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<table>
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<tr>
<th>THE WORKING PHASE</th>
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<tbody>
<tr>
<td>STRATEGY: INFORMATION SHARING</td>
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<tr>
<td>OBJECTIVE</td>
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</tr>
<tr>
<td>• To provide the academic staff with the findings of the situation analysis and the challenges that must be overcome to achieve food science and technology graduates who demonstrate similar required graduate capabilities</td>
<td></td>
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<tr>
<td>ACTIONS</td>
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<tr>
<td>• Providing the findings of the situation analysis</td>
<td></td>
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<tr>
<td>• Providing the challenges identified in the situation analysis</td>
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<tr>
<td>• Providing information about the teaching and learning of graduate capabilities</td>
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</tr>
</tbody>
</table>
THE WORKING PHASE

STRATEGY: CAPACITY BUILDING

OBJECTIVES

To facilitate the academic staff to identify approaches to address the following challenges noted in the situation analysis:

1. Allow students from different educational backgrounds to demonstrate similar required graduate capabilities
2. Develop and enhance required employability skills; more specifically, digital technology skills and digital literacy among students within the context of the food science and technology environment
3. Develop and enhance the required communication skills of students within the context of the food science and technology environment
4. Develop and enhance the required leadership, management and organisational skills of students within the context of the food science and technology environment
5. Develop and enhance the entrepreneurial skills of students within the context of the food science and technology environment
6. Develop and enhance the basic diversity skills of students within the context of the food science and technology environment
7. Enhance students’ personal attributes of self-esteem and self-confidence
8. Develop and enhance the students’ ability to integrate and apply the multi-disciplinary knowledge, skills and competencies gained from all the modules in a food science and technology programme to solve ‘real world’ problems in the context of the food, beverage and allied industries

ACTIONS

1. Allowing students from different educational backgrounds to demonstrate similar required graduate capabilities by:
   - Assisting the academic staff to identify approaches to:
     o Create an engaged learning environment
     o Develop the professional identity of students
     o Engage and collaborate with stakeholders
     o Contextualise teaching and learning within the food science and technology workplace environment
     o Implement quality assurance mechanisms
2. Employability skills, including digital technology skills and digital literacy
   • Assisting academic staff to identify appropriate teaching and learning approaches and assess students’ achievement of the required:
     o Generic employability skills
     o Digital technology skills
     o Digital literacy

3. Communication skills
   • Assisting academic staff to identify approaches to promote teaching and learning and assess students’ achievement of the required:
     o Listening skills
     o Verbal and non-verbal skills
     o Written skills
     o Level of English proficiency

4. Leadership, management and organisational skills
   • Assisting academic staff to identify approaches to promote teaching and learning and to assess students’ achievement of the required:
     o Leadership skills
     o Management skills
     o Organisational skills

5. Entrepreneurial skills
   • Assisting academic staff to identify approaches to promote teaching and learning and to assess students’ achievement of:
     o Entrepreneurial skills

6. Diversity skills
   • Assisting academic staff to identify approaches to promote teaching and learning and to assess students’ achievement of diversity management skills including:
     o Tolerance of differences
     o Attitudes of acceptance

7. Personal attributes of self-esteem and self-confidence
   • Assisting academic staff to identify approaches to promote the enhancement of the desired personal attributes of students, including:
     o Self-esteem
     o Self-confidence

8. Application of the multi-disciplinary knowledge, skills and competencies
   • Assisting academic staff to identify approaches to promote teaching and learning and to assess student achievement of the:
- Application of food science and technology knowledge, skills and competencies to:
  - Solve problems
  - Make decisions
  - Develop new food products and processing methods

### TERMINATION PHASE

**STRATEGY: TERMINATION AND ASSESSMENT OF THE FACILITATION PROCESS**

**OBJECTIVE**
- To evaluate the academic staff’s experience of the facilitation process

**ACTIONS**
- Assisting the academic staff to reflect on their experience of the facilitation process
- Evaluating the strengths and weakness of the facilitation process

Strategies are initially aimed at fostering a cooperative relationship between the facilitator and the academic staff teaching in food science and technology programmes. Following this, the facilitation actions must provide the academic staff with the essential knowledge, skills and competencies to create an engaged learning environment. Academic staff must be assisted to identify approaches to address the domains of the programme learning outcomes, student-centred teaching and learning approaches, and competency-based assessment practices (refer to Figure 5.4). Once these initial facilitation actions have been achieved, facilitative actions must be presented to assist academic staff in identifying approaches to address the specific challenges identified through the empirical findings.

#### 6.3 INITIATION PHASE – STRATEGY: RELATIONSHIP BUILDING

**6.3.1 Objective: Relationship building**

To ensure the success of the facilitation process, trusting relationships based on mutual respect need to be formed between the agent, or facilitator, and the recipients, or academic staff, and also between the academic staff participating in the facilitation workshop. To meet this objective, certain actions aimed at relationship building,
stimulating a positive attitude towards undergraduate teaching, and developing a common purpose and commitment from the academic staff to engage with the objectives of the workshop, need to be carried out at the start of the workshop.

6.3.1.1 Action: Relationship building

It will not be possible to address the objectives of the workshop without first establishing a beneficial and cooperative relationship between the facilitator and the academic staff. Engagement between the academic staff needs to be fostered as it is best if the challenges identified through the situation analysis are addressed holistically at the programme level rather than through individual actions at the level of each module. Foundational principles of the workshop must include voluntary engagement, collaboration and cooperation; all contributions by the workshop participants are equally valuable for the positive outcome of the workshop.

To achieve the credibility of the facilitator and to build confidence in the workshop outcomes, the credentials of the facilitator must be presented to the academic staff. It is the facilitator’s role to guide and control the group process and to develop a mutual understanding and a common purpose between the workshop participants. A brief background and overview of this study must be provided to the academic staff. They will then be familiarised with the concept of graduate capabilities and the related concepts of employability skills, graduateness and the desired personal attributes of graduates. A case must be made to move from a narrow disciplinary content focus to produce graduates who meet the varied and ever-changing expectations of societal stakeholders.

6.3.1.2 Action: Promoting a positive attitude towards undergraduate teaching

For the facilitation process to be successful, academic staff must be not only willing but also capable of integrating the required generic graduate attributes within the modules they teach. To engage the academic staff in addressing the challenges identified through the situation analysis, the facilitator must aim at cultivating a positive attitude towards undergraduate teaching in the workshop. To achieve this, the
facilitator must motivate the implementation of the approaches identified through the outcomes of the workshop as a possible area of future research. In addition, a high level of collaboration and cooperation between the academic staff teaching within the various modules within the programme/s must be promoted. This collaboration must ensure that all the required graduate capabilities and programme learning outcomes are addressed across the modules of the programme/s. To achieve this, the process of curriculum mapping (Joyner, 2016:63; Robley, Whittle & Murdoch-Eaton, 2005:321; Spencer, Riddle & Knewstub, 2011:217; Yorke, 2006:7) must be introduced to the academic staff to assist them in developing a visual map of all the modules in the programme/s with the associated module learning outcomes. The academic staff must further be assisted to view this approach as a tool to identify gaps, areas of overlap and possible areas for improvement within the existing programme/s and the individual modules they teach.

6.3.1.3 Action: Agreement of the objectives and outcomes of the workshop

The facilitator must guide the workshop participants to formulate and agree on common workshop objectives and the desirable outcomes pertinent to their unique educational environment. The shared responsibility of the workshop participants towards the outcome of the workshop must be stressed and agreement must be reached on how the workshop outcomes will be recorded for subsequent action.

6.4 WORKING PHASE – STRATEGY: INFORMATION SHARING

6.4.1 Objective: Information sharing and reaching a common understanding

The objective was formulated to share the findings generated through the situation analysis of this study with the academic staff. A coordinated and mutual understanding that the academic staff must assist food science and technology students in developing the required graduate capabilities during their undergraduate studies is foundational to the positive outcome of the facilitation process. The challenges that need to be addressed during the facilitation process must be presented to the academic staff. Based on this information, the academic staff can be guided to achieve
a common understanding of the challenges identified through the situation analysis. Furthermore, a shared commitment must be reached to use the facilitation process to identify approaches that address these challenges.

6.4.1.1 Action: Sharing the situation analysis findings with the academic staff

In a previous action, the academic staff were empowered with a common understanding of the concept of graduate capabilities and the associated concepts of employability skills, graduateness, and personal attributes as conceptualised in this study. This subsequent action must build on the previously facilitated understanding of graduate capabilities by presenting the academic staff with the graduate capabilities required from newly graduate food scientists and technologists as identified through the situation analysis. The evidence that comparable graduate capabilities are needed from food scientists and food technologists, despite their different educational backgrounds, must be presented to the academic staff. The academic staff must be guided to establish a coordinated and mutual understanding of the required graduate capabilities of food scientists and technologists.

6.4.1.2 Action: Sharing the challenges formulated from the situation analysis with the academic staff

The specific challenges that the academic staff must address for food science and technology students to attain similar required graduate capabilities as identified through the situation analysis will also be shared with the academic staff. They must then be guided to engage with the identified challenges and formulate the challenges as workshop outcomes that are pertinent to their teaching environment.

6.4.1.3 Action: Sharing information about the teaching and learning approaches to embedding graduate capabilities

Knowledge pertaining to embedding the generic graduate attributes, individual core competencies and employability skills within the existing programmes must be presented to the academic staff (Bentley et al., 2013:652; Hadiyanto, 2010:12). In
addition, information about relevant approaches that can be considered to develop and enhance citizenship and to prepare students to engage with life-long learning (Barnett & Coate, 2005:25; Annala & Mäkinen, 2012:292) must be presented. The academic staff must be asked to brainstorm ideas on how the outcome of students demonstrating the required graduate capabilities could be achieved within the context of the existing food science and technology programme/s in which they teach.

6.5 WORKING PHASE – STRATEGY: CAPACITY BUILDING

6.5.1 Objective: Food science and technology graduates who demonstrate similar required graduate capabilities

The objective was formulated to assist academic staff in identifying approaches to address the overarching challenge of enabling food science and technology students from different educational backgrounds to demonstrate similar graduate capabilities aligned with the findings of the situation analysis. To achieve this objective, the academic staff must be assisted to identify approaches to:

- create an engaged learning environment that includes student-centred teaching and learning approaches;
- develop the professional identity of students;
- engage and collaborate with stakeholders;
- contextualise teaching and learning within the food science and technology workplace environment; and
- implement quality assurance mechanisms.

6.5.1.1 Action: Creating an engaged learning environment

This action will assist the academic staff in identifying approaches to enhance the learning environment in which they teach. The action will commence by drawing the academic staff’s attention to the fact that they should not only focus on disciplinary-specific content, but also meet the expectations of societal stakeholders. Newly qualified food science and technology graduates must demonstrate the graduate
capabilities that employers expect of them from ‘day one’. Moreover, academic staff must be made aware that higher education institutions must increasingly “identify, map, monitor and submit to external scrutiny” evidence of excellence in teaching (Cleaver, Lintern & McLinden, 2018:xxi). The academic staff must be provided with literature supporting innovative ways to engage students in actively participating in their own learning, since these are more successful than face-to-face lectures (Cleaver et al., 2018:xxii; Collaço, 2017:40; Wright, 2011:92). However, the academic staff may not have the knowledge, skills and competencies or experience necessary to successfully implement student-centred teaching, learning and assessment approaches (Plush & Kehrwald, 2014:1). Therefore, academic staff will be sensitised towards some teaching and learning approaches that encourage student-centred learning, such as inquiry-based learning (Bruner, 1961:21), problem-based learning (Barrows & Lynda, 2007:1; Delise, 1997:1; Schmidt, 2012:21; Walker, Leary, Hmelo-Silver & Ertmer, 2015:1-4), project-based learning (Blumenfeld, Soloway, Marx, Krajcik, Guzdial & Palinscar, 1991:369; Dining, 2017: Abstract), and experiential learning using work placement (Hackman & Oldham, 1976:250; Kolb, 1984:38) or scenario-based learning (Errington & Cook, 2010:1).

Central to creating an engaged learning environment is encouraging the students to develop self-directed learning skills. Self-directed learning, derived from adult education, is the self-imposed responsibility of an individual to identify their learning needs and then formulating how they will achieve their learning goals (Candy, 1991:33; Fry et al, 2009:14; Knowles, 1975:18). Self-directed learning is a prerequisite to lifelong learning and keeping current on both generic graduate attributes and discipline-specific knowledge, skills and competencies (Bloom & Kitagawa, 1999:20). Knowles (1975:33-34) proposes that to encourage students to become self-directed learners who are capable of effectively engaging in lifelong learning requires academic staff to act as facilitators of learning rather than adopting teacher-directed learning approaches. Food science and technology is multidisciplinary in nature and promoting self-directed learning will encourage students to integrate information that might be related to understanding and resolving the problem they are faced with. Students often report that they are overwhelmed by the notion of self-directed learning and so the academic staff must be empowered to support students to becoming more active in
the learning process to allow students to be more adaptable, productive and autonomous when entering the workplace (Kearns, 2001:55).

a) Implementing problem-based learning

The academic staff must be presented with an introduction to problem-based learning, which is a form of inquiry-based learning (Bruner, 1961:21). The problem-based learning approach allows students to take responsibility for their own learning (Candy, 1991:33; Knowles, 1975:18) and enhances their problem-solving skills (SA CHE, 2011:17) by encouraging them to apply their prior knowledge to solve problems (Barrows & Lynda, 2007:92-93; Delise, 1997:4).

Problem solving skills can be developed using problem-based teaching strategies such as case studies and simulations, either individually or in a team (Fry et al., 2009:450). The problems are usually presented to the student or group of students as a scenario or case-study that may be encountered within their discipline and workplace; either fictional, authentic or real. To encourage authentic problems, employers can be encouraged to develop, and present case studies based on issues that may realistically be faced in the workplace environment (Archer & Davidson, 2009:13). Student learning is achieved by the academic staff facilitating the students in solving the problem. The students are required to interpret the problem/s correctly, gather the necessary information to solve the problem/s, formulate several options to solve the problem/s and then present their final conclusions with evidence to support the conclusions (Barrows & Lynda, 2007:92-93). This teaching approach encourages the application and integration of prior knowledge and provides the opportunity for contextual learning through the scenario that is presented to the students. Academic staff will be guided to identify opportunities to include problem-based learning activities within their teaching if they do not already do so. If they already make use of project-based learning activities, the academic staff will be encouraged to share their experiences.
b) Implementing project-based learning

Project-based learning must be presented to the academic staff as a possible approach to encourage student-centred learning and allow students to engage with a meaningful learning experience (see 6.4.1.2 c). This teaching approach allows students to work on a project over an extended period that engages them, either individually or as a group, to solve a real-world problem or to answer a complex question (Blumenfeld et al., 1991:369). Students are required to apply their knowledge, skills and competencies by developing a product or presentation for a real audience. This teaching approach is suggested to be useful in developing deep meaning-oriented learning, generic graduate attributes such as critical thinking, problem-solving and teamwork skills that are associated with workplace readiness, especially if the project is work-based (Dinning, 2017:Conclusion), in addition to self-directed and life-long learning skills (Maolosi et al., 2008:39).

1. Project-based learning is an approach commonly used in food science and technology where students are required to develop a food product, including the formulation, manufacturing process and packaging, usually during the final year of their undergraduate study. The academic staff will be guided to share the current project-based learning activities that they adopt in their teaching and learning. A brainstorming exercise must be implemented that allows the academic staff to identify possibilities to refine and improve on the current project-based learning activities. These approaches must include learning activities to address the challenges associated with the development and enhancement of the generic graduate attributes identified as essential graduate capabilities through the situation analysis. Assessment strategies to evaluate the attainment of digital technology skills and digital literacy, communication skills, entrepreneurial skills, and leadership, management and organisational skills, which were identified as challenges through the findings of the situation analysis, must be identified.
Implementing meaningful learning experiences

The concept of incorporating meaningful experience in promoting learning and student achievement, including the Job Characteristic Theory of Hackman and Oldham (1976:250) and the Experiential Learning Theory of Kolb (1984:38), will be presented to the academic staff. The Job Characteristic Theory (refer to Figure 6.2) suggests three psychological states of an individual based on five core job characteristics.

**Figure 6.2: Job Characteristics Theory (adapted from Hackman & Oldham, 1976:250)**

In the case of this study, the job characteristics are those of being an effective and professional food scientist or technologist based on the required graduate capabilities identified through the situation analysis. Hackman and Oldham (1976:250) propose that the core job characteristics (refer to Figure 6.2) can be manipulated to achieve authentic learning. When the core job characteristics are coupled with constructive feedback and opportunities for improvement, students may tend to display the
required learning outcomes (Hackman & Oldham, 1976:250). The facilitation process will support the academic staff to identify how they could possibly implement the principles of the Job Characteristics Theory (Hackman & Oldham, 1976:250) into their teaching and learning approaches to improve the required graduate capabilities of food scientist and technologists.

The Experiential Learning Theory proposed by Kolb (1984:141, 38) declares “learning is the process whereby knowledge is created through the transformation of experience”. This theory proposes four cyclic stages of learning based on meaningful experience. The first stage of the learning cycle is having the experience, then reflecting on the experience, followed by learning from the experience, and finally reinforcing learning by application (Kolb, 1984:141). Encouraging reflection on the experience is proposed to enhance authentic learning, and if the students are subsequently required to apply what they have learnt, learning is reinforced (Healey & Jenkins, 2000:185; Kolb, 1984:38; Kolb, Boyatzis & Mainemelis, 2000:227). Kolb’s learning cycle will be proposed to the academic staff as a possible option for implementation at different levels of the existing educational programme/s to engage students through learning experiences.

In addition, the modified Miller’s pyramid of Cruess, Cruess and Steinert (2016:182) must be presented as an approach for selecting teaching pedagogies and assessment techniques appropriate to each level of the pyramid as shown in Figure 6.3. The academic staff must be assisted to identify how the five levels of the modified Miller’s pyramid can be implemented into the teaching, learning and assessment practices of the module/s they teach. Discussion on how the fifth level of ‘being’ a professional food scientists and technologists can be assessed must be encouraged.

The facilitator will assist the academic staff to identify how work-integrated learning can assist students to assimilate theory and practice within the workplace of their chosen discipline of study (Kruger, 2014:160; SA CHE, 2011:4; SA DHET, 2012b:11; Natoli, Jackling, Kaider & Clark, 2013:5; Samadi, 2013:1; Tran, 2016:62). Work-integrated learning enhances the student learning process through “observation, participation and completion of tasks that demonstrate competency” within a work
The role of work integration in developing the employability skills of students and a professional identity must be shared with the academic staff (LeGrand et al., 2017:118; Lowden et al., 2011:vii; Pillai et al., 2012:189; Tran, 2016:62; Tymon, 2013:445). However, to ensure the success of work-integrated learning or work placement (Zou & Chan, 2016:384), the academic staff must be guided to identify how learning can be optimised to develop the “preparedness for practice” as a food scientists and technologist (Burford, Whittle & Vance, 2014:1 & 8).

The workshop participants must also be allowed to share their own teaching and learning experiences, approaches and the tools that they perceive as effective in engaging students and promoting meaningful learning. After this, the academic staff will be presented and encouraged to discuss some other research-led teaching methodologies that have been found to be effective in supporting the attainment of intellectual and core competencies, positive attitudes and preparing students for lifelong learning (Hadiyanto, 2010:18; Murdoch-Eaton & Whittle, 2012:120).

Figure 6.3: Amended Miller’s Pyramid adapted to food science and technology education (Adapted from Cruess et al., 2016:182; Miller, 1990:S63)
It is recognised that institutional policies and the teaching competencies of individual academic staff ultimately impacts on the choice of teaching approaches. For this reason, the academic staff must be encouraged to identify teaching and learning approaches and activities that they feel capable of and comfortable to implement within the environment of their higher education institution.

d) Implementing competency-based assessment

Competency-based assessment practices are core to an engaging learning environment. The facilitator must guide the academic staff to identify assessment practices, approaches and methods that not only measure acquired knowledge, but also the level and acquisition of generic graduate attributes, skills and competencies (Hoadley & Jansen, 2009:173; Ippeciel & ElAtia, 2014:27; Robley, Whittle & Murdoch-Eaton, 2005:325). Assessment for competence requires several strategies using different levels of assessment (see Figure 6.3). These include the levels proposed by Miller (1990:S63) and modified by Creuss et al. (2016:182):

- ‘is’ or ‘being’ or assessment of the values, attitudes and qualities required to display professional identity (see 6.5.1.2) as a food scientist and technologist;
- ‘knows’ or knowledge assessed through traditional objective assessment methods;
- ‘knows how’ or assessment of competence through demonstrating the intellectual skills required to interpret, analyse and apply the knowledge;
- ‘shows how’ by demonstrating the technical skills to perform certain procedures, methods or tasks under supervision; and
- ‘does’ which is demonstrating the needed expertise in a ‘real world’ situation when working independently.

Academic staff must be assisted to identify and engage in future research to recognise valid and reliable competency-based assessment methods that measure the attainment of the five levels outlined above within the context of food science and technology education.
6.5.1.2 Action: Enhancing the professional identity of food science and technology students

The objective of this facilitation process is to assist the academic staff in identifying interventions to develop the professional identity (Molinero & Pereira, 2013:1605) of food science and technology students during their undergraduate studies. The facilitator will present evidence to the academic staff that the strong interaction with mentors and peers and authentic working experiences within the context of the student’s chosen discipline are recognised as central to developing a professional identity and “learning to be” (Borden, 2008:149; Zou & Chan, 2016:383). Forming such a ‘community of practice’ (Wenger, 2010:179) in food science and technology within a higher education institution may be a challenge. Academic staff must be assisted to identify and implement activities that are known to promote the development of students’ professional identity (Trede, Macklin & Bridges, 2012:365; Shaw & Bailey, 2016:18). Approaches such as work-integrated learning and work placements (Burford et al., 2014:8; Zou & Chan, 2016:384), and using ‘real world’ simulations (MacLean, Geddes, Kelly & Della, 2019:15) will be presented to the academic staff as alternative approaches to developing the professional identity of students as food scientists and technologists. Real-world simulations can provide authentic learning experiences exposing students to professional roles and practices in a simulated environment (Zou & Chan, 2016:383). Therefore, the facilitator must assist the academic staff in brainstorming possible ideas for ‘real world’ simulations that can be developed in collaboration with stakeholders that will serve the purpose of developing the students’ professional identity. These simulations must sufficiently engage the academic staff and eventually the students within the virtual community of practice to allow professional identities to develop (Zou & Chan, 2016:384).

Developing a professional identity as a food scientist or technologist requires socialisation within the discipline of food science and technology (Creuss et al., 2016:181; Maxwell & Armellini, 2019:76). The academic staff must identify approaches to allow students to accept responsibility for developing their own professional identity in collaboration with role models and mentors (Creuss et al., 2016:184). The value of professional associations that promote the occupational interests and knowledge
required of members and develop activities that foster professional identity is well recognised (Borden, 2008:149; Shaw & Bailey, 2016:18). Academic staff must therefore be assisted to identify approaches that can be implemented to encourage students to become members, and to actively engage in the South African Association of Food Science and Technology.

**6.5.1.3 Action: Contextualising teaching and learning within the food and allied industries workplace environment**

The challenge was identified to develop and enhance the required graduate capabilities of food science and technology students within the context of the food science and technology workplace environment. To address this challenge, the academic staff need to have knowledge beyond their disciplinary expertise to extend to current industry practice and awareness of the structures and function of the various workplaces in which their students will be employed in the future (AU Precision Consulting, 2007:24). Stakeholder engagement and collaboration must assist academic staff in identifying more with the food and allied industries sector and enabling them to contextualise what they teach within the environment of the food, beverage and allied industries. This action must therefore support the academic staff to identify approaches that will strengthen engagement and collaboration with societal stakeholders; not only to foster a better understanding between them, but also to enrich the academic staff’s experience of the food science and technology environment. A possible approach is the establishment of a collaborative committee that engages with food science and technology education matters. In some institutions, such committees do exist and may function on different levels of efficiency, but these committees are not present in every institution. The academic staff will be assisted to plan for the implementation of such a committee, or if such a committee exists, to identify approaches to re-energise and improve the functioning of the committee.

Another possible approach to strengthen academic staff and stakeholder engagement could be to identify ‘industrial mentors’ who can advise and engage with them on ways to conceptualise their teaching within the discipline. This collaboration
could include scrutiny of teaching content, developing collaborative problem-based scenarios (6.5.1.1 a) to solve ‘real-world’ problems, developing student projects (see 6.5.1.1 b), developing video clips and online activities to be included into a blended learning model (Garrison & Kanuka, 2004:95), and identifying opportunities for academic staff to spend time in the food science and technology work environment.

6.5.1.4 Action: Implementing a quality assurance approach

To achieve an engaged learning environment (refer to Figure 5.5) requires that the programme learning outcomes are continually aligned with the ever-changing and varied needs of societal stakeholders. In addition, it is important to ascertain if food science and technology students have achieved the required graduate capabilities when they graduate and take up employment or when they continue with postgraduate studies. This action aims to facilitate the academic staff to identify approaches that can be implemented to assure the quality of learning and the continued relevance of the food science and technology programme/s. The facilitator must propose the concept of the “assurance of delivery for graduate employability model” (Oliver, 2010:120; Refer to 2.5.1 & Figure 2.10) to achieve ‘fluid’ programme learning outcomes that will reflect the expectations of stakeholders. The academic staff must be assisted to identify how the principles of the model can be implemented to allow the programme to remain up-to-date and to continually evolve with the changing needs of the external environment.

A fundamental requirement of the ‘assurance of delivery’ approach is stakeholder engagement and the academic staff must be helped to identify mechanisms for stakeholder feedback as previously described. However, feedback is not enough if it is not going to be used to inform future actions. Therefore, the academic staff must be assisted to identify approaches that can be implemented to evaluate and act on stakeholder feedback to bring about a cycle of continuous improvement. Such mechanisms may include the formation of a committee (refer to 6.5.1.3) comprised of academic staff, students and alumni and other interested stakeholders that meets annually or at least bi-annually to consider feedback and to brainstorm possible improvements that can be implemented into the programme/s.
6.5.2 Objective: Developing and enhancing employability skills, including digital technology skills and digital literacy

The challenge to develop and enhance general employability skills, including the digital technology skills and digital literacy of food science and technology students, was identified. Therefore, the objective of this facilitation process is to assist the academic staff in identifying approaches to develop and enhance the required employability skills, including digital technology skills and digital literacy, within the context of the food science and technology discipline and workplace environment. To achieve this, actions must be proposed that allow academic staff to identify appropriate teaching, learning and competency-based assessment strategies to measure if students demonstrate the required skills.

6.5.2.1 Action: General employability skills

The facilitator must support the academic staff to consider developing a stand-alone competency-based module dealing with general employability skills if such a module does not already exist in the current programme structure. Should such a module exist, then the academic staff must be assisted to identify approaches to align the content of the existing module with the required general employability skills identified in the empirical phase of this study. The academic staff must then be assisted to share and brainstorm ideas to identify possible additional relevant module content, such as job hunting and career management skills (Bridgstock, 2009:31). The facilitator must assist the academic staff in identifying teaching and learning approaches and competency-based assessment methods to measure students’ attainment of these employability skills. Engagement and collaboration with recently employed graduates, alumni and employers must be proposed when developing the learning outcomes of the module to ensure its relevance. This module should be included in the programme structure prior to students graduating or embarking on work-integrated learning.
6.5.2.2 Action: Digital technology skills and digital literacy

The use of digital technology to transform and enhance student learning within an engaged learning environment is becoming an increasing focus of higher education institutions (Karnad, 2013:2; U.S. Department of Education, 2017:4). The challenge was identified to improve the digital technology and digital literacy skills of food science and technology students so that they can engage with the process of using technology in employment (Leahy & Wilson, 2014:178), and for life-long learning (Ala-Mutka, Punie & Redecker, 2008: IPTS policy brief: Digital competence for life-long learning). To implement technology-enabled teaching, learning and assessment practices within food science and technology programmes requires that a) the academic staff have the attitudes, knowledge, skills and competencies to implement the effective use of technology within their teaching, and b) that students can use technology effectively to engage with the digital learning experiences developed by the academic staff. Therefore, the facilitation process will firstly aim to assist the academic staff in developing a positive attitude towards technology and addressing the necessary knowledge and capabilities to enable them to introduce technology into their teaching, learning and assessment practices. For technology to have a positive effect on student learning requires that it must address specific goals and needs (U. S. Department of Education, 2017:9). Therefore, the academic staff must be assisted to identify opportunities where technology can be used to address the challenges identified through the situation analysis of this study.

Food science and technology students must not only be able to interact effectively with learning experiences that make use of technology; the challenge of developing and enhancing the required digital technology skills and digital literacy that they must demonstrate upon graduating must also be addressed. Therefore, this facilitation process will aim to assist the academic staff in identifying and implementing approaches to enhance the digital technology skills and digital literacy of students, and assess whether the essential skills and competencies that are required in employment have been achieved.
Many food science and technology programmes may include a separate introductory competency-based digital technology skills module in the programme structure in the first period of undergraduate study. This module is suggested to be ‘conceptualised’ and independent of the discipline of study. However, such a module allows the current level of digital technology skills among food science and technology students to be assessed and provides students with access to technologies that they may not have available to them in other environments. To reinforce learning achieved by students in the stand-alone module, the academic staff must be assisted to identify suitable web-based digital literacy courses that are freely available on the internet, for possible incorporation into this stand-alone module and/or inclusion in the individual modules they teach. The academic staff must be facilitated to include possible teaching and learning initiatives that will embed digital technology skills and digital literacy (Karnad, 2013:8), such as implementing a blended learning approach (Garrison & Kanuka, 2004:95), creating digital classrooms (Kong, 2014:160), networking and collaboration opportunities through online platforms (European Commission, 2014:31; Kong, 2014:160), and digital storytelling (Chetty & Pather, 2015:3).

Furthermore, the academic staff must be assisted to include interventions in their teaching, learning and assessment that will engage students in digital technology skills and digital literacy, including the following: Online submission of reports, projects, assignments and tasks; preparing written reports, projects, assignments and tasks in digital formats such as videos; developing food science and technology online apps; and developing food science and technology-specific online games, to name a few. Academic staff must also be facilitated to not only rely on digital literacy to source and evaluate information for assignments and projects, but they must identify and implement assessment practices by including assessment criteria that evaluate the competent use of digital technology and evidence of digital literacy.

The facilitator must encourage the academic staff to implement an online discussion platform to encourage ‘virtual’ interaction to exercise digital communication skills and digital literacy in a safe and anonymous environment. To facilitate the formation of such an online discussion platform, the academic staff must identify and recruit a diverse cross-section of participants. Ideally, the participants of the online discussion
group should include stakeholder representatives, food science and technology students – including undergraduates and postgraduates – the academic staff of the food science and technology-specific modules, and alumni. Furthermore, such platforms can facilitate communication skills (see 6.5.3) within the context of the discipline and can positively influence the development of the professional identity of students.

6.5.3 Objective: Enhancing communication skills

The challenge to develop and enhance communication skills among food science and technology students within the context of the discipline of food science and technology was identified through the situation analysis. Therefore, this facilitation process aims to assist the academic staff in identifying approaches that can be implemented to develop and enhance the required communication skills.

6.5.3.1 Action: Communication skills

To facilitate academic staff to enhance students’ communication skills within the context of food science and technology, the facilitator must firstly share the required communication skills identified through the findings of this study with the academic staff. To facilitate the academic staff with the competency to embed the required communication skills within the individual modules they teach, a communications expert must be invited to the workshop. The communications expert must share knowledge with the academic staff on the role of communication, the barriers to communication, and how learning and improvement of communication skills can be encouraged. Academic staff must then be assisted to identify possible learning approaches that have been shown in literature to enhance communication skills among students (Goodwin, 2015:36). The possible learning activities that can be considered for implementation include digital storytelling (Ivala, Gachago, Condy & Chigona, 2014:217), report writing (Jones, 2006:117), engaging in video games (Barr, 2018:283) and watching videos of verbal communication situations (MacLean et al., 2019:15).
Other options to consider include replacing face-to-face lectures with workshops and assessment approaches such as oral presentations, posters and videos, as these are reported to improve written, graphical, verbal and non-verbal communication (San-Valero, Robles, Ruano, Marti, Cháfer & Badia, 2018: Abstract). Such approaches are proposed to allow students to evaluate their own realism and to boost their reflective learning (Maclean et al., 2019:15). The academic staff must be encouraged to share how they currently facilitate and assess communication skills within the modules they teach. They should also be assisted to identify other possibilities to embed communication skills in the modules through learning and assessment activities.

Facilitation of communication skills in real-world situations is recognised (Al-Alawneh, 2009:115) and the value of work placement in this regard was highlighted by the survey participants in response to the open-ended questions (refer to Table 4.25). However, enhancement of communication skills during work-integrated learning cannot be assumed. Therefore, the academic staff must be supported, in collaboration with work-integrated learning employers, to identify approaches to enhance communication skills within the workplace and to identify mechanisms to measure if the outcome of enhanced communication skills is achieved.

Work-integrated learning is not possible within the current structure of some of the existing food science and technology undergraduate programmes. Therefore, this facilitation action must empower the academic staff to identify alternative approaches to enhance the required communication skills within the context of the food science and technology environment.

The concept of forming a digital discussion platform was introduced earlier (refer to 6.5.2.2). Academic staff must be assisted to implement a discussion platform to enhance communication skills within the context of the discipline by encouraging students’ interaction with others, including peers, academic staff and other societal stakeholders. The academic staff must be supported to consider the implementation of role-playing (Rao & Stupans, 2012:427) as a possible tool for facilitating communication skills within the context of the discipline. To achieve this, the facilitation process must assist academic staff in identifying opportunities to develop real-world
scenarios in collaboration with stakeholders. An example of a possible scenario is a food safety team meeting, as such meetings are typical within the environment of the food, beverage and allied industries. This scenario will allow students the opportunity to prepare an agenda for the meeting, assign responsibilities to team members, conduct the meeting by including the requirement for ‘team members’ to report back both verbally and in writing on specific agenda items, and allowing ‘team members’ to act in different roles within the meeting, such as acting as the chairperson or secretary. These team meetings can be video recorded, and students can watch, critique and reflect on the experience at a later stage.

6.5.4 Objective: Developing and enhancing leadership, management and organisational skills

The challenge to develop and enhance the required leadership, management and organisational skills of food science and technology students within the context of the discipline was identified through the situation analysis. To this end, the objective of this facilitation process is to assist the academic staff in identifying approaches to develop and enhance the required leadership, management, and organisational skills of students within the context of the food science and technology environment.

6.5.4.1 Action: Leadership, management and organisational skills

Jackson (2015:356) proposes that most of the required leadership, management and organisation skills of food science and technology graduates are developed during work-integrated learning. However, as previously mentioned, not all food science and technology programmes include a period of work-integrated learning and other interventions to develop leadership, management and organisation skills must be considered (Xu & Patmor, 2012:252). This facilitation process aims to assist the academic staff in identifying opportunities to embed the required leadership, management and organisational skills into the learning outcomes of the modules that they teach if they are not already captured. The facilitator must assist the academic staff in identifying suitable teaching approaches that, if implemented, will support students to attain the required leadership, management and organisational skills.
Competency-based assessment practices to measure the level of accomplishment of these skills must also be identified. Academic staff must be assisted to make use of experiential learning activities (refer to 6.5.1.1 c) and periods of work-integrated learning to reinforce the learning achieved. Again, the need for academic staff to engage employers in identifying methods that can be used to enhance the leadership, management and organisational skills learning outcomes during work-integrated learning must be emphasised. This will include identifying and implementing competency-based assessment practices that employers can use to assess the achievement of these skills during work-integrated learning.

6.5.5  Objective: Developing and enhancing entrepreneurial skills

The challenge to develop and enhance the entrepreneurial skills of food science and technology students during undergraduate studies was identified through the situation analysis. Therefore, the objective of this facilitation process is to assist the academic staff in identifying student-centred teaching and learning approaches, and competency-based assessment methods to develop and enhance the entrepreneurial skills of students during their undergraduate studies.

6.5.5.1  Action: Entrepreneurial skills

This facilitation process aims to assist academic staff in identifying and implementing innovative teaching approaches to facilitate the teaching and learning of entrepreneurial skills among food science and technology students. The development of an entrepreneurial skills-based project must be presented to the academic staff as a possible approach to develop and enhance the required skills. The facilitation process must assist the academic staff in identifying and developing a project that will require students to develop and produce a food or beverage product on a small scale that they must launch and market as an entrepreneurial venture. In addition to developing entrepreneurial skills, such project-based learning exercises (refer to 6.5.1.1 b) will also develop and enhance other skills such as the integration and application of food science and technology knowledge, skills and competencies.
6.5.6 **Objective: Developing and enhancing diversity management skills**

The challenge to develop and enhance the diversity management skills of food science and technology students was identified through the situation analysis. Enhancement of students’ diversity management skills is proposed to be a general and unintended outcome of South African higher education (Griesel & Parker, 2009:18). However, there is a need to reiterate and enhance the diversity management skills within the context of the food science and technology workplace. Therefore, the objective of this facilitation process is to assist the academic staff in identifying approaches that will develop and enhance the basic diversity skills required in the food science and technology workplace environment.

6.5.6.1 **Action: Diversity management skills**

The facilitator must assist the academic staff in recognising opportunities to embed diversity management skills across the modules of the food science and technology programme/s. However, to reinforce these skills and assess that they are being attained by students, diversity management skills must also be included as a component of the stand-alone module suggested to develop and enhance the students’ general employability and career management skills (refer to 6.5.2.1). To address the challenge of assessing diversity management skills within the context of the food, beverage and allied industries, the academic staff must be assisted to consider developing ‘real-world’ scenarios where conflict or misunderstanding may arise within the work environment. These scenarios must be developed through collaboration between employers and academic staff. The scenarios can then be presented to students with pre-determined answer options. Feedback and discussion on the students’ answers can be used for reflection and to reinforce the learning of diversity management skills.

6.5.7 **Objective: Enhancing the personal attributes of self-esteem and self-confidence**

The challenge to enhance the personal attributes of self-esteem and self-confidence of food science and technology students was identified through the situation analysis.
Therefore, the objective of this facilitation process is to assist the academic staff in identifying approaches that can be implemented to enhance the self-esteem and self-confidence of students during undergraduate studies.

6.5.7.1 Action: Self-esteem and self-confidence

This action proposes that the academic staff must facilitate the self-esteem and self-confidence levels of the students during their undergraduate studies. This can be achieved by engaging students in activities which can boost self-esteem and self-confidence and other closely related attributes such as resilience, flexibility, adaptability and decision-making. Rather than identifying approaches in isolation, the facilitator must support the academic staff to brainstorm approaches (Burns & Sinfield, 2004:47) that could be implemented within their environments. Most higher education institutions have student support services who can provide them guidance and ideas on how to build self-esteem and self-confidence.

Student-centred learning is a central theme to address the challenges identified in the situation analysis, and in so doing, develop and enhance the required graduate capabilities of food science and technology students. Student-centred learning allows students to take ownership of, and to make decisions about, their own learning, which is proposed to boost their self-esteem and self-confidence (Cleaver et al., 2018:xxii; Collaço, 2017:40; Wright, 2011:92). It has also been shown that students who follow programmes that incorporate work-integrated learning are more confident and have a more positive outlook compared to students who do not have work-integrated exposure (Purdie, Ward, Mcadie, King & Drysdale, 2013:122). Possible approaches which academic staff might consider have been described previously, including the possibility of incorporating problem-solving exercises and challenges (refer to 6.5.1.1a) within modules where students can brainstorm and then report back verbally. The possibility of a digital discussion platform has also been mentioned (refer to 6.5.2.2). The academic staff need to be made aware of the positive impact on students’ self-confidence through providing constructive and prompt feedback and using encouragement to allow students to view ‘mistakes’ as learning opportunities, rather than failures.
6.5.8 Objective: Integrating and applying the graduate capabilities

The situation analysis identified the challenge of developing and enhancing the ability of food science and technology students to integrate and apply the required graduate capabilities that they have attained across all the modules of a food science and technology programme. This facilitation process therefore aims to assist the academic staff in identifying approaches to support students to integrate and apply the required graduate capabilities, especially the combined food science and technology-specific knowledge, skills and competencies, within the context of the ‘real world’ of the food, beverage and allied industries workplace.

6.5.8.1 Action: Integrating and applying the graduate capabilities

This action will support the academic staff to identify and implement teaching and learning approaches that include meaningful experiences (refer to 6.5.1.1 c) that are documented and interspersed by reflection, analysis and cognitive problem-solving in ‘real-world’ situations. The approaches proposed to the academic staff must include methods that incorporate experience (refer to 6.5.1.1 c), such as work-integrated learning, experiential learning and integrated contextual learning.

A case has previously been made for the value of work-integrated learning in developing and enhancing the graduate capabilities of food science and technology students prior to graduating. The perceived benefits of work-integrated learning must be presented to the academic staff. These perceived benefits included:

- assisting the students in contextualising the required employability skills within the food science and technology workplace environment;
- enhancing the students’ self-confidence;
- allowing students to apply their theoretical food science and technology knowledge, skills and competencies within the workplace to solve problems and make decisions; and
- orientating the student to the ‘world of work’.
Greater student numbers and limited work-integrated learning placement opportunities are challenging. Alternate strategies, such as simulated learning through a virtual workplace and problem-based and project-based learning (Coorey & Firth, 2013:20), must be introduced to the academic staff as possible alternatives. The facilitator must assist the academic staff in identifying feasible approaches for implementing ‘real-world’ experiences through an integrated contextual learning approach that combines face-to-face lectures with problem-based learning within the modules they teach. Integrated contextual learning is proposed to encourage student learning through social interaction within a simulated ‘real life’ situation (Coorey & Firth, 2013:21), although simulated learning practices are suggested to be less effective than workplace experience (Burford et al., 2014:8).

The facilitation process has previously addressed the need for academic staff to identify approaches to collaborate with societal stakeholders on food science and technology educational matters (refer to 6.5.1.3 & 6.5.1.4). The facilitator must reiterate the need for engagement, cooperation and collaboration between the academic staff and stakeholders, as these are key to the success of the work-integrated learning and integrated contextual learning. Implementing work-integrated learning requires close collaboration between the academic staff and the employers to identify job opportunities that provide meaningful learning experiences. Employers should then be engaged with assessment processes to measure if the students have achieved the desired skills (De Vos, De Hauw & Van der Heijden, 2011:438). Likewise, simulated learning scenarios in a virtual workplace, and in ‘real world’ problem-based and project-based exercises must be developed as a collaboration between the academic staff and employers of food scientists and technologists. The academic staff must also be assisted to identify other opportunities to integrate and contextualise food science and technology knowledge, skills and competencies within the context of the ‘real world’ food, beverage and allied industries workplace environment. Approaches such as job shadowing, simulated learning experiences and workplace tours must be presented to the academic staff for consideration (SA CHE, 2011:4; SA DHET, 2012b:11; Ryan et al., 1996:355; Tran, 2016:62).
6.6 TERMINATION PHASE – STRATEGY: TERMINATION OF THE FACILITATION PROCESS

At the termination of the facilitation process, the academic staff must be asked to reflect on their experience of the facilitation process and evaluate whether the workshop goals and outcomes have been achieved. Therefore, the objective of this facilitation process is to evaluate if the academic staff have been assisted in identifying approaches to address the challenges identified through the situation analysis.

6.6.1 Action: Termination of the workshop

The facilitator must assist the academic staff to reflect on their experience of the facilitation process. Each of the academic staff participating in the workshop will be invited to report if they perceive that the goals and outcomes of the facilitation process were realised, and to comment on what they personally gained through the facilitation process. Suggestions for improvements and follow-up facilitations will be encouraged.

6.7 SYNTHESIS OF CHAPTER SIX

This chapter provided a description of the facilitation process and the educational strategies to assist the academic staff teaching within the discipline of food science and technology programmes to create an engaged learning environment and address the challenges identified through the situation analysis. These strategies aimed to empower the academic staff with the necessary attitudes, knowledge, skills and competencies to address the challenges within the structure of the existing food science and technology programme/s in which they teach. By addressing the challenges, the outcome of future food science and technology graduates who demonstrate similar graduate capabilities that meet the expectations of societal stakeholders could be achieved. The strategies were grouped into broad categories, namely relationship building, information sharing, capacity building and termination strategies. Specific actions to achieve the facilitation process were described.
The next chapter will conclude this thesis by reviewing the research process that was implemented, presenting conclusions, identifying limitations and proposing recommendations and possible future research.
CHAPTER SEVEN: REVIEW OF THE RESEARCH PROCESS: CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

And will you succeed?
Yes! You will, indeed!
(98 and ¾ percent guaranteed) (Dr Seuss, 1990).

7.1 INTRODUCTION

Higher education institutions are expected to prepare graduates to meet the diverse and continually changing expectations of the societal stakeholders in the community and environment they serve. The graduates’ employment expectations must also be considered (Adam, 2009:84; Halliday, 2004:279; Harwood, 2010:417; Mouzakitis, 2010:3914). Graduates must not only demonstrate the required disciplinary knowledge and ‘day-one’ skills and competencies (Welsh et al., 2009:771) to act effectively when they take up employment (Barnett & Coates, 2005:54; Flynn et al., 2013:246; Holmes, 2013:1046; Lowden et al., 2011:vi; Oliver, 2011:2); they must also have developed the human abilities to continually learn and adapt (Barnett, 2004:247; Steur et al., 2012:862).

This study adopted the term ‘graduate capabilities’ to describe the complex blend of the required generic graduate attributes, the desirable personal attributes and the essential disciplinary-specific knowledge, skills and competencies that a food science and technology graduate must possess to be successful after graduating. Available literature proposes certain graduate capabilities that are desirable for food scientists and technologist in the EU to be effective in the workplace (Flynn et al., 2013:246). Minimum educational guidelines against which undergraduate food science and technology programmes can be approved are also available (IFT, 2019:6-8). Based on this information and the worldwide perception that graduates do not meet the requirements of employment or the expectations and needs of society (Archer & Chetty, 2013:135; Chetty, 2012:5; Litchfield et al., 2010:519; SA DHET, 2011:3; Wilton, 2011:13 & 2012:604) the main research question was formulated as:
Chapter Seven summarises and concludes this research study and reviews the research process that was followed to answer the main research question and sub-questions. Conclusions emerging from the situation analysis and the formulation of educational strategies for the facilitation of the academic staff teaching food science and technology students are described. Finally, the limitations of this study are presented, and recommendations are formulated.

Figure 7.1 provides an overview of the structure of the chapter.

![Diagram of chapter structure]

**Figure 7.1: Overview of the structure of the chapter**

In view of the main research question, the following more specific theoretical and empirical objectives were formulated:
• Conduct a situation analysis making use of a self-developed questionnaire to identify the required graduate capabilities of South African food science and technology graduates.
• Identify challenges based on the findings of the situation analysis that academic staff teaching food science and technology students must address.
• Develop a conceptual framework to guide the facilitation process of the academic staff to enable them to address the challenges.
• Formulate educational strategies to facilitate a positive attitude and the educational knowledge, skills and competencies of academic staff.

7.2 THE RESEARCH PROCESS

To achieve these objectives, this study was conducted in two phases, namely an empirical phase and a facilitation phase. The empirical phase implemented a situation analysis to address the first two objectives of this study, while the facilitation phase aimed to address the third and fourth objectives.

7.2.1 The empirical phase: The situation analysis

To achieve the first objective of this study, the empirical phase conducted a situation analysis to identify the required graduate capabilities of South African food science and technology graduates to meet the expectations of societal stakeholders. Data were collected by developing a questionnaire specific to this study and deploying it as a web-based survey. Literature pertaining to graduate capabilities (Barnett & Coate, 2005:95; Daniels & Brooker, 2014:66; Oliver, 2011:7), generic graduate attributes (Barrie, 2006:217; Hinchliffe & Jolly, 2011:563; Hooker & Whistance, 2016:156; Steur et al., 2012:862), employability skills (Andrews & Higson, 2008:411; Bridgstock, 2009:31; Pool & Shewell, 2007:218), graduateness (Coetzee, 2012a:120; Hinchliffe & Jolly, 2011:564) and personal attributes (Barnett, 2009:248; Barrie, 2004:272; Holmes, 2013:1046), informed the sections of the questionnaire probing the required generic graduate attributes and desired personal attributes. The food science and technology content of the questionnaire was based on the literature available pertaining to discipline-specific knowledge, skills and competencies (Bohlscheid &
Clarke, 2012:8; Floros et al., 2010:572; Flynn et al., 2013:253; IFT, 2011:7; Johnston et al., 2014:18-9; Wirakartakusumah & Yada, 2012:1). The societal stakeholders invited to participate in the situation analysis included food scientists and technologists, non-government organisation representatives, government representatives, staff from higher education institutions and employers of food scientists and technologists, most of whom were members of the South African Association of Food Science and Technology.

7.2.1.1 Findings of the situation analysis

An important finding of the situation analysis acknowledged that, in the workplace, similar graduate capabilities are expected from food science and food technology graduates despite their different educational backgrounds. Furthermore, the graduate capabilities perceived as essential for food science and technology students upon graduation were found to be:

- the generic graduate attributes comprising general employability skills, including digital technology skills and digital literacy; communication skills; leadership, management and organisational skills; entrepreneurial skills; and diversity management skills;
- the required personal attributes of self-esteem and self-confidence; and
- the application of required graduate capabilities, specifically the essential food science and technology knowledge, skills and competencies within the context of the food, beverage and allied industries workplace environment.

The empirical findings of this study were corroborated by findings of a study conducted to identify the required knowledge, skills and learning outcomes for food scientists and technologists to be successful in careers in the food industry within the EU (Flynn et al., 2013:247; Ho et al., 2011:1-11). A comparison of the findings with the minimum standards and essential learning outcomes for accreditation of undergraduate food science and technology programmes by the IFT (2019:6-8) found that there was agreement between the empirical findings of this study and the essential food science and technology discipline-specific knowledge, skills and competencies required by the
organisation. However, the empirical findings in this study identified more specific generic graduate attributes and desired personal attributes than those of the IFT (2019:8).

The findings of the situation analysis also contributed to the debate about the differentiation between a food scientist and a food technologist. Literature supported that there is little to distinguish the two (Floros et al., 2010:572; IFST, 2017:1; IFT, 2011:4; Kostaropoulos, 2012:111; Potter & Hotchkiss, 1998:1; refer to 1.3.2). The empirical findings showed that, although the survey participants distinguished between the South African food scientists and technologists based on their educational background, both must demonstrate similar graduate capabilities.

To address the second objective of this study, the findings of the situation analysis were scrutinised, and several challenges or themes were formulated that needed to be addressed by the academic staff teaching food science and technology students. These challenges, if addressed by the academic staff, would support students to achieve similar required graduate capabilities aligned with the findings of the situation analysis. Graduate food scientists and technologists who demonstrate the required graduate capabilities will be more employable as they will meet the needs and expectations of societal stakeholders.

7.2.2 The facilitation phase

Teaching and learning approaches to develop and enhance the generic graduate attributes and personal attributes of students during higher education are complex and multifaceted (Yorke, 2006:14). Therefore, the need to facilitate the academic staff to demonstrate a positive attitude and the necessary educational knowledge, skills and competencies to effectively address the challenges identified in the situation analysis, was identified. Thus, the third objective of this study was to develop a conceptual framework that would guide the facilitation process to enhance the current teaching, learning and assessment practices of the academic staff to empower them to address the identified challenges.
The conceptual framework was based on the practice-oriented theory of Dickoff et al. (1968:423). In line with this theory, the following aspects were identified:

- **Context** – the environment of the South African higher education institutions offering food science and technology undergraduate programmes.
- **Agent** – the facilitator who will provide guidance and support to the academic staff teaching food science and technology students through a facilitation process and specific actions.
- **Recipient/s** – the academic staff teaching food science and technology students at whom the facilitation process is aimed.
- **Dynamics** – the energy source to address the tension between higher education and societal stakeholders in terms of food science and technology students not demonstrating the required graduate capabilities when they graduate.
- **Process/procedure or activity** – planned facilitation process and educational strategies to assist the academic staff to address the challenges identified through the findings of the situation analysis.
- **Terminus** – the termination of the facilitation process.
- **Outcome** – facilitated academic staff who exhibit a positive attitude and have the necessary educational knowledge, skills and competencies to create an engaged learning environment and address the challenges identified through the findings of the situation analysis.

The facilitation phase aimed to address the fourth objective of this study and comprised several phases, namely the relationship building phase, the working phase and the termination phase. Each phase aimed to address specific objectives to create an engaged learning environment and overcome the challenges identified in the situation analysis by targeted actions. A half-day workshop, to be repeated at each of the higher education institutions offering food science and technology undergraduate programmes, is planned to implement the facilitation process. The envisaged outcome of the facilitation process is facilitated academic staff who are confident to create an engaged learning environment and address the challenges identified through the findings of the situation analysis. By so doing, the academic staff will support the food science and technology students to achieve similar graduate capabilities that align
with the findings of the situation analysis of this study, despite their different educational backgrounds.

7.3 CONCLUSIONS

Ultimately, this study aimed to answer the main research question and the research sub-questions. The first research sub-question was:

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Sub-question 1:
What graduate capabilities are required of newly graduated food scientists and technologists that will meet the requirements and expectations of South African societal stakeholders?
```

The findings of the situation analysis answered the first research sub-question through engagement with relevant societal stakeholders. Based on the findings of the situation analysis, challenges and themes were identified that needed to be addressed by the academic staff teaching food science and technology students to support the students in attaining the required graduate capabilities. Several of the formulated challenges related to the development and enhancement of the students’ generic graduate attributes and personal attributes. Therefore, it is recommended that South African food science and technology programmes should include a stronger focus on the teaching, learning and assessment of the required generic graduate attributes and personal attributes of self-esteem and self-confidence identified through the situation analysis.

This study then aimed to answer the second research sub-question, namely:

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Sub-question 2:
To what extent are the international food science and technology educational requirements and guidelines identified through literature applicable in the South African context?
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Based on the findings of the situation analysis, it was concluded that the IFT’s “Core Competencies in Food Science” (IFT, 2011:6-8) and the recently updated standards and essential learning outcomes (IFT, 2019:6-8) are relevant to the South African context; particularly for the essential fundamental food science and technology knowledge, skills and competencies. However, the ‘success skills’ outlined in the ‘core competencies’ (IFT, 2011:6-8; IFT 2019:6-8) do not adequately capture the required generic graduate attributes and desirable personal attributes of newly graduated food scientists and graduates that are expected by South African societal stakeholders.

The third research sub-question related to the academic staff teaching food science and technology students:

<table>
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<th>Sub-question 3:</th>
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<tbody>
<tr>
<td>How can the academic staff be facilitated to have the necessary attitudes, knowledge, skills and capabilities to optimally enable undergraduate food science and technology graduates to demonstrate the required graduate capabilities?</td>
</tr>
</tbody>
</table>

To answer the third and final research sub-question, a conceptual framework was developed to describe what must be done to facilitate the academic staff to address the challenges identified through the situation analysis. Then a facilitation process comprising a relationship phase, a working phase and a termination phase was formulated to show how the academic staff can be facilitated based on the educational strategies of relationship building, information sharing and capacity building.

The facilitation process aimed to assist the academic staff in developing a positive attitude towards undergraduate teaching and in having the necessary educational knowledge, skills and competencies to successfully implement an engaged learning environment and address the challenges identified through the situation analysis. In so doing, the academic staff will be able to proactively support the food science and technology students that they teach to accomplish similar graduate capabilities, despite their different educational backgrounds.
By successfully answering the three research sub-questions, the main research question was answered.

What educational strategies can be formulated to facilitate the professional development of academic staff teaching undergraduate food science and technology students to deliver food science and technology graduates who will meet the requirements and expectations of societal stakeholders?

7.4 CONTRIBUTION TO THE KNOWLEDGE OF FOOD SCIENCE AND TECHNOLOGY EDUCATION

This study’s contributions to knowledge include:

- A research-led situation analysis that allowed for the identification of the required graduate capabilities of newly graduated South African food scientists and technologists to meet the expectations of societal stakeholders.
- The deductive development of a conceptual framework to guide the facilitation of the academic staff teaching food science and technology students which may be applicable to other disciplines.
- The development of educational strategies and actions to facilitate academic staff teaching food science and technology students to address the challenges identified through the situation analysis so that they can support students to attain the required graduate capabilities.

7.5 LIMITATIONS OF THE STUDY

The findings of the situation analysis were based on empirical data collected using a questionnaire developed and deployed as a web-based survey during 2015. It was determined that the reported findings still appear relevant. On analysing the data collected through the survey some oversights and areas for improvement in the questionnaire content and structure were identified. The length of the survey seemingly influenced some participants who accessed the survey but chose not to
complete and/or submit it. Students and graduates with less than one year of work experience were excluded as survey participants using filtering questions at the start of the survey. Not having input from students and new graduates may possibly be viewed as a limitation. However, despite the filtering questions, 11 percent of the survey participants had either no or less than one year of work experience. A comparison of the findings generated from the data collected from the work-inexperienced participants was compared to that collected from participants with greater work experience and it was found that there was general agreement between the findings.

Although the sample for the survey was purposive, this was not considered as a limitation to the findings of the situation analysis. The survey participants needed to have an educational and work experience background for the collected data to provide useful information pertinent to achieving the aims and objectives of this study. However, using purposive sampling may have limited the transferability of the knowledge generated by this study to contexts other than food science and technology.

The conceptual framework developed in the second phase of this study aimed to guide a facilitation process to empower academic staff teaching food science and technology students through a professional development workshop. However, the workshops were not conducted and the lack of practical application of the research findings are acknowledged as a limitation of this study.

### 7.6 RECOMMENDATIONS FOR APPLICATION

The following recommendations are made in respect of this study:

#### 7.6.1 Application to theory

The findings of the situation analysis conducted in this study generated theory about the graduate capabilities that undergraduate food science and technology students must demonstrate when they graduate to meet the expectations of societal
stakeholders. The methodology followed, and the questionnaire to collect data to identify the required graduate capabilities of food science and technology graduates can be adapted to be relevant in other contexts.

By describing a conceptual framework for the facilitation of the academic staff teaching in the discipline of food science and technology, theory about empowering academic staff to develop and enhance the graduate capabilities of their students is generated. The educational strategies proposed to embed the required generic graduate attributes within the context of the discipline contributes to the theory of teaching, learning and assessment of generic graduate attributes in other contexts.

7.6.2 Application to practice

The facilitation process developed through this study must be implemented to assist academic staff teaching food science and technology students to be capable of implementing an engaged learning environment and address the challenges identified through the situation analysis. The facilitated academic staff will, in turn, enable food science and technology students to achieve the required graduate capabilities expected by societal stakeholders. Academic staff and societal stakeholder engagement and collaboration must be strengthened in the future to support academic staff to contextualise their teaching, learning and assessment to the food, beverage and allied industries workplace environment.

The proposed facilitation process provides a framework which is flexible and does not prescribe methods or approaches but rather guides and supports academic staff to use their creativity to enhance the learning environment and engage students in the learning process. Therefore, the facilitation process can probably be adapted to other contexts to empower academic staff to develop and enhance the graduate capabilities of students of higher education; especially, facilitating the students to achieve the required generic graduate attributes within the context of their discipline of study.
7.6.3 Application to educational policy

Coetzee (2012b:26) proposes that the inclusion and development of generic graduate attributes in South African higher education have received little attention; a view supported by Bezuidenhout (2011:3). By creating a frame of reference of the importance that societal stakeholders place on the generic graduate attributes, including employability skills and the characteristics of graduateness, this study supports and informs the development of higher education policy in this regard.

7.7 IMPLICATIONS FOR FUTURE RESEARCH

This study paves the way for many areas of future research. These include:

- Revisiting and refining the questionnaire developed for this study and redeploying it to collect more data and to include questions that will allow participants to indicate the expected level of competence of the graduate capabilities.
- Developing core learning outcomes for South African food science and technology undergraduate qualifications based on the recently updated “Core Competencies in Food Science” of the IFT (2019:6-8) and alignment with the empirical findings of the situation analysis of this study. These core learning outcomes can be used in future to develop new food science and technology programmes, and to evaluate the learning outcomes of existing programmes to identify any gaps that need to be addressed.
- Implementing the facilitation process by conducting the proposed facilitation workshop/s to ascertain if the intended outcome of the professional development of the academic staff is achieved.
- Developing novel teaching, learning and assessment approaches that incorporate experiential learning activities within the context of the food, beverage and allied industries workplace environment.
7.8 CONCLUDING REMARKS

The idea for this study started with comments from employers that the recently graduated food scientists and technologists they employ do not meet their expectations. What is it that the employers are expecting, I wondered? And how do I, as an academic teaching food science and technology students, assist students in developing and enhancing the complex characteristics, knowledge, skills and attributes, or ‘graduate capabilities’ that their future employers expect from them? The passion to answer these questions eventually led to the idea for this study. Although I have found answers to some of my initial questions, many more questions come to the fore that need answers. I guess that is the nature of research!

7.9 SYNTHESIS OF THE CHAPTER

This final chapter concluded and described the research process followed in this study. Conclusions were drawn which provided answers to the research sub-questions. These, in turn, contributed to answering the main research question. This study’s original contributions were unpacked, and the limitations were identified. Finally, recommendations were made based on the outcomes of the research process and the implications for future research were identified.
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Dear D Metcalfe

Ethical Clearance Number: 2014-033

Re: The work preparedness and employability of South African Food Science and Technology graduates.

Ethical clearance for this study is granted subject to the following conditions:

- If there are major revisions to the research proposal based on recommendations from the Faculty Higher Degrees Committee, a new application for ethical clearance must be submitted.
- If the research question changes significantly so as to alter the nature of the study, it remains the duty of the student to submit a new application.
- It remains the student’s responsibility to ensure that all ethical forms and documents related to the research are kept in a safe and secure facility and are available on demand.
- Please quote the reference number above in all future communications and documents.

The Faculty of Education Research Ethics Committee has decided to

- Grant ethical clearance for the proposed research.
- Provisionally grant ethical clearance for the proposed research

Recommend revision and resubmission of the ethical clearance documents
Sincerely,

Prof Geoffrey Lautenbach
Chair: FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
6 June 2014
<table>
<thead>
<tr>
<th>Author/source</th>
<th>Category</th>
<th>Theme</th>
<th>Brief description</th>
<th>Model &amp;/or broad categories of attributes/skills identified</th>
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<tbody>
<tr>
<td>Andrews &amp; Higson,</td>
<td>Journal article</td>
<td>Employability - Europe</td>
<td>The article looks at the concept of graduate employability in four European countries (UK, Austria, Slovenia &amp; Romania) from the perspective of employers and graduates. The authors conceptualise and identify key individual- and business-related skills and competencies required by employers of graduates to determine if business graduates in Europe meet the demands of the marketplace. Employers are described to value discipline-related knowledge and skills, interpersonal competencies and want work-ready graduates capable of working with little supervision. Work-based learning was identified as being valuable in developing employability.</td>
<td>Discipline-specific knowledge and skills, Interpersonal competencies, Work without supervision</td>
</tr>
<tr>
<td>Barrie, 2004</td>
<td>Generic</td>
<td>Generic graduate attributes - Australia</td>
<td>The author observes that a general lack of cohesion in view points and understanding has led to limited success in developing graduate attributes. Academics responsible for facilitating the development of graduate attributes do not share a common understanding of the nature of graduate attributes, or the methods of teaching and learning which may facilitate the development of such attributes. Four broad categories of understanding are identified, namely precursor, complimentary, translational and enabling conceptions. A research approach is adopted to revise a university’s existing graduate attribute policy statement. The revised two-tiered policy statement recognises the relationship between generic attributes and disciplinary context and interpretations when developing graduate attributes.</td>
<td>Three overarching graduate attributes: Scholarship, Citizenship, Life-long learning. Supported by five clusters: 1. Research and inquiry 2. Information literacy 3. Personal and intellectual autonomy 4. Ethical, social and professional understanding 5. Communication</td>
</tr>
<tr>
<td>Bennett, Dunne &amp;</td>
<td>Journal article</td>
<td>Employability model</td>
<td>These publications enhance the understanding of skills development in higher education and employment. The 1999 publication proposes a model of delivery of employability in higher education based on five interrelated elements. This model captures some of the key elements of employability but does not address aspects of citizenship or the role of life-long learning.</td>
<td>Model of delivery consisting of five elements 1. Disciplinary knowledge 2. Disciplinary skills 3. Workplace awareness 4. Workplace experience 5. Generic skills</td>
</tr>
<tr>
<td>Author/source</td>
<td>Category</td>
<td>Theme</td>
<td>Brief description</td>
<td>Model &amp;/or broad categories of attributes/skills identified</td>
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</table>
| Bennett, et al., 2000         | Publication of Society for Research into Higher Education (SRHE) | Core & generic skills – UK              | The 2000 publication terms ‘core’ and ‘generic’ skills are conceptualised - it is proposed that the term ‘core’ is used in relation to discipline-specific skills, and ‘generic’ is used to describe skills that are transferable to all aspects of life and are independent of discipline. Models of delivery are described; a model based on a person’s performance where ‘generic’ skills interlock with disciplinary content, disciplinary skills, workplace awareness and workplace experience are proposed. | Identify 4 ‘generic’ management skills:  
1. Management of self  
2. Management of others  
3. Management of information  
4. Management of task |
| Bloom & Kitagawa, 1999       | Report prepared for ‘The Conference Board of Canada’ | Employability skills                   | The report was prepared in response to pressure to develop employability skills, or ‘career capital’ to meet the skills shortage within Canada. The report outlines information that can be used by stakeholders such as employers and educators to develop and assess employability skills in a more strategic manner. A definition and the key features of employability skills is provided, as well as guidelines to develop and assess employability skills. The report proposes that employability skills can be viewed as the application of ‘common sense and practical judgement’. | Three categories of employability skills are proposed:  
1. Academic skills: ability to communicate, think and learn  
2. Personal management skills: positive attitudes and behaviours, responsibility and adaptability  
3. Teamwork skills |
| Bridgstock, 2009              | Journal article                               | Employability – Australia               | This author suggests that it is not enough for higher education to produce employable graduates and that graduates must be able to proactively engage and self-manage employment to have successful careers. The notion of developing employability through generic skills to meet the needs of multiple employers is challenged. Rather, it is suggested that to enhance the immediate and sustainable employability of graduates, career management competencies should be developed. | Self-management and career management competencies |
| Coetzee, 2012a                | Chapter in book                               | Graduateness – South Africa             | Coetzee (2012a:120) defines graduateness as personal and intellectual development. Eight core skills and attributes that constitute the graduateness of economic and management sciences students are identified. In agreement with Barrie (2004), the author categorised the eight core skills into three | Graduateness comprises of three domains:  
1. Scholarship  
   - Problem-solving and decision-making: |
<p>| Author/source          | Category                               | Theme                                          | Brief description                                                                                                                                                                                                                                                                                                                                 | Model &amp;/or broad categories of attributes/skills identified |
|-----------------------|----------------------------------------|                                               |                                                                                                                                                                                                                                                                                                                                                 |                                                            |
| Dench, Hillage, Reilly &amp; Kodz, 2000 | Report on an employers’ skill surveys | Employability in the food manufacturing industry – UK | One of the aims of the study reported by Dench et al., was to identify skill deficiencies and gaps related to food production processes which were obvious during recruitment of employees and within the existing workforce of the food manufacturing industry in the UK. The required skills are categorised into three broad categories: personal attributes including personal behaviour, characteristics and attitudes; generic employability skills; and vocational food manufacturing industry-specific skills. Employers’ perceptions of the reasons for difficulties in recruitment of suitable employees, as well as the reasons for skill gaps amongst existing employees, were probed and possible solutions suggested. | Three categories: 1. Personal attributes 2. Generic employability skills: IT and computing skills; literacy and numeracy skills; communication skills; team working; problem-solving; multi-skilling, flexibility and adaptability; life-long learning skills 3. Vocational food manufacturing sector-specific skills: food hygiene: health and safety in manufacturing; food quality; manual and maintenance skills |
| Hillage &amp; Pollard, 1998 | Research brief of UK Dept. Education &amp; Employment | Employability – UK | The purpose of this publication is to serve as a common base to develop and assess government policy on employability. The authors provide a definition for employability and suggest that to be employable, four key elements must be addressed. Employability is suggested as a means of improving access | Four attributes of employability 1. Knowledge, skills and attitudes |</p>
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<tr>
<th>Author/source</th>
<th>Category</th>
<th>Theme</th>
<th>Brief description</th>
<th>Model &amp;/or broad categories of attributes/skills identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>McQuaid &amp; Lindsay, 2005</td>
<td>Journal article</td>
<td>Employability – UK</td>
<td>The authors analyse the current and past use of the concept of employability, including its evolution over time and the influence of context. The value of employability as a concept that can inform labour market policy, is highlighted. A model of employability is proposed that contains three interrelated components: individual factors, personal circumstances, and external factors (p209).</td>
<td>1. Individual factors – employability skills and attributes 2. Personal circumstances 3. External factors – labour demand</td>
</tr>
<tr>
<td>Oliver, 2011</td>
<td>Report of the Australian government initiative – Australian Learning and Teaching Commission, Inc.</td>
<td>Graduate outcomes – Australia</td>
<td>Oliver authors a report which acts as a guide on the progress made by the ALTC (ALTC 2011a &amp; 2011b) projects and fellowships working on assuring graduate outcomes in Australia. The project differentiates between discipline-specific outcomes and generic outcomes or ‘graduate attributes’. A quality assurance framework is provided which consists of four stages namely, initiation, deployment, review and improvement (p8). The first two stages correlate with the aims of this study, namely determining the required graduate outcomes and identifying approaches and strategies to facilitate the development of the identified outcomes. ‘Deployment’ examines ‘developing’ or ‘fostering’ generic outcomes and focusses on assessment to a required quality ‘standard’. The author observes that although Australian universities have documented graduate outcomes, few reflect he standard to which these should be demonstrated by the students (p2).</td>
<td>‘Graduate attributes’ is used to describe generic outcomes of higher education as follows: 1. Communication – written and oral 2. Critical and analytical, sometimes creative and reflective, thinking 3. Problem-solving – idea generation &amp; innovation 4. Information literacy and technology 5. Learning and working independently and collaboratively 6. Ethical and inclusive engagement</td>
</tr>
<tr>
<td>Author/source</td>
<td>Category</td>
<td>Theme</td>
<td>Brief description</td>
<td>Model &amp;/or broad categories of attributes/skills identified</td>
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</table>
| Pool & Sewell, 2007 | Journal article | Employability – UK | Pool and Sewell propose a model for employability that seeks to address the perceived complexity of previous models such as the USEM model. Five elements essential to employability are identified, and the inclusion of each is motivated. Emotional intelligence is proposed as essential to employability and the importance of work and life experience in developing employability is highlighted. The role of life-long learning in continually developing employability is accepted. | CareerEDGE Key to Employability Model  
- Career development learning  
- Experience – work/life  
- Degree-specific knowledge, skills and understanding  
- Generic skills  
- Emotional intelligence  
(Refer to Figure 2.2) |
| Reich, 2002 | Book | Employability – USA | Reich identifies that advanced economies require professionals with expertise that first, emphasises development of new knowledge and second, exploits knowledge of others through analysis and the application of interpersonal skills. Professionals must meet a series of achievements captured by three over-arching attributes.  
1. Imagination and creativity  
2. Relevant disciplinary understanding and skills  
3. Generic skills that allow for the effective application of disciplinary understanding |
| UK, National Committee of Inquiry into Higher Education, 1997 | Report commissioned by UK government | Employability – UK | The so-called Dearing Report describes employability in terms of the achievement of skills for life. It recommends that higher education focus on developing skills which are the “key to the future success of graduates whatever they intend to do in later life” (p133). Skills identified include: communication skills; numeracy; information technology; learning how to learn/personal development; planning; problem-solving; and, team working. |
| York, 2006 | Publication of the HE Academy – Series: Learning & Employability | Employability – UK | The relationship between the economy and higher education is described through the concept of employability. Employability is described as complex learning and the capability function in a job rather than a list of core skills. The role of life-long learning in employability is highlighted. Graduateness is described as more general than employability and includes ‘general dispositions, qualities and skills’ (p 4). The role of higher education, the graduate and the employer in developing employability is considered. Four areas identified in undergraduate study to achieve employability:  
- Construct and apply knowledge  
- System thinking and ability to contextualise  
- Experimentation (intuitively or analytically) |
<table>
<thead>
<tr>
<th>Author/source</th>
<th>Category</th>
<th>Theme</th>
<th>Brief description</th>
<th>Model &amp;/or broad categories of attributes/skills identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yorke &amp; Knight, 2006</td>
<td>Publication of the HE Academy – Series: Learning &amp; Employability</td>
<td>Employability – UK</td>
<td>It is proposed that undergraduate programmes should consider four areas to achieve employability.</td>
<td>Collaboration skills such as communication and team-working</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A framework for embedding employability into the curriculum is presented. The issues that must be considered when embedding employability into new or existing curricular are highlighted - it is proposed that this should be done across the whole programme rather than individual modules. Curriculum auditing is described as a manner of evaluating how and where employability is embedded into the curriculum. The USEM model of employability based on four inter-related components is presented and remains respected in employability studies. The model supports the alignment of good teaching practice with the development of employability.</td>
<td>USEM employability model (p5) which interrelates Understanding Skillful practice Efficacy beliefs, personal skills and qualities Metacognition (Refer to Figure 2.1)</td>
</tr>
</tbody>
</table>
Dear __________

INVITATION TO PARTICIPATE IN A FOCUS GROUP DISCUSSION: Work readiness and employability of food scientists and technologists of South African Higher Education Institutions.

This serves as an invitation to participate in a focus group discussion to be held as follows:

DATE : Wednesday, 11 March 2015.
TIME : 13:00 to 15:00.
VENUE : Doornfontein Campus (DFC) of the UJ (map available on request)
        John Orr Building, Room 2205.

OVERVIEW OF THE STUDY

Firstly, the study aims to determine the food science and technology (FST) graduate attributes required by South African (SA) stakeholders. Secondly, the study aims to determine to what extent recently qualified FST graduates are meeting these requirements.

The study assumes that graduate attributes embrace employability, work-readiness and graduateness and include a set of discipline specific skills, knowledge and proficiencies, personal attributes and an array of generic or core employability skills. Combined, these
graduate attributes allow the individual to secure and succeed in their occupation and meet the expectations of themselves, their parents, employers and society as a whole.

**PURPOSE OF THE FOCUS GROUP**

Graduateness, work readiness and employability themes as well as the FST specific knowledge and skills have been identified from the literature review and pre-screened for appropriateness to the study. The purpose of this focus group is to present the draft themes for comment to ensure that they include what the stakeholders consider to be important employability and graduateness attributes of food scientists and technologists (FSTs) graduating from SA Higher Education Institutions.

The themes will then be used to produce specific questions for an online survey which will then be piloted on a small group of UJ work integrated learning employers to test the validity and ensure that the questions are understood and not ambiguous. Once it has been refined, it will be made available electronically to the larger FST community for response.

**METHOD OF DATA COLLECTION**

The data will be collected through a voice tape-recording which will allow discussions to be transcribed and analysed for accuracy when developing the final survey questions. This information will be stored confidentially.

**ETHICS**

Ethical clearance for this study has been granted by the UJ Faculty of Education’s Ethical Committee. There is unlikely to be any discomfort associated with being a participant in the focus group.

**CONFIDENTIALITY**

Your responses will remain anonymous (as best they can be in a focus group) and will be treated as confidential at all times. The results of the focus group discussions will be captured in the content of the online survey and will not allow participants to be identified.
The decision to take part in this focus group is voluntary and remains your choice. You may withdraw your consent to participate at any time with no consequence to you.

Please contact me should you require any additional information or have questions about the research study.

Yours sincerely,

Denise Metcalfe
Senior lecturer and PhD candidate
Department of Biotechnology and Food Technology
## ANNEXURE D: Composition of the focus group

### Final composition of the focus group

<table>
<thead>
<tr>
<th>Constituency/segment</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academia</td>
<td>1</td>
</tr>
<tr>
<td>Retailers</td>
<td>1</td>
</tr>
<tr>
<td>Dairy sector</td>
<td>1</td>
</tr>
<tr>
<td>Beverage sector</td>
<td>2 alcoholic 1 non-alcoholic</td>
</tr>
<tr>
<td>Food manufacturing sector</td>
<td>1</td>
</tr>
<tr>
<td>Food ingredients manufacturers and suppliers</td>
<td>1</td>
</tr>
<tr>
<td>Government stakeholders</td>
<td></td>
</tr>
<tr>
<td>Dept. of Agriculture, Forestry &amp; Fisheries, Chief Directorate: Inspection &amp; Quarantine Services, Directorate: Food Safety &amp; Quality Assurance</td>
<td>2</td>
</tr>
<tr>
<td>Dept. of Health, Directorate of Food Control</td>
<td>1</td>
</tr>
<tr>
<td>South African Association for Food Science and Technology (SAAFoST) representative</td>
<td>1</td>
</tr>
<tr>
<td>South African Association for the Flavour and Fragrance Industry (SAAFFI) representative</td>
<td>1</td>
</tr>
</tbody>
</table>
ANNEXURE E: Introduction to the focus group discussion

INTRODUCTION TO THE FOCUS GROUP DISCUSSION: 11 March 2015 from 13:00 to 15:00

TITLE OF STUDY
Employability and work readiness of food scientists and technologists of South African Higher Education Institutions.

OVERVIEW OF THE STUDY

Firstly, the study aims to determine the food science and technology (FST) graduate attributes required by South African (SA) stakeholders. This will be done through an on-line survey made available to SAAFoST members and circulated directly to key stakeholders, employers within the food and related industries and food scientists and technologists themselves. In addition key stakeholders may be contacted for follow-up interviews.

Once the graduate requirements are identified, the study will focus on determining to what extent recently qualified FST graduates are meeting these requirements and to identify the challenges they face on entering into employment.

The study assumes that graduate attributes embrace employability, work-readiness and graduateness and include a set of discipline specific skills, knowledge and competencies, personal attributes and an array of generic or core skills. Combined, these graduate attributes allow the individual to secure and succeed in their occupation and meet the expectations of themselves, their parents, employers and society as a whole.

Definitions of Employability, etc.

“A set of skills, knowledge and personal attributes that make an individual more likely to secure and be successful in their chosen occupation(s) to the benefit of themselves, the workforce, the community and the economy.” (Yorke & Knight, 2006).

“…knowledge, skills, competencies and values (combined to represent ‘graduate attributes’)...” (G&P, 2009:7)
PURPOSE OF THE FOCUS GROUP

Graduateness and employability themes have been identified from the literature review and pre-screened for appropriateness to the study. The purpose of this focus group is to present the draft themes for comment to ensure that they include what the stakeholders consider to be important employability and graduateness attributes of FSTs.

The themes will then be used to produce specific questions for the survey which will then be piloted on a small group of UJ work integrated learning employers to test the validity and ensure that the questions are understood and not ambiguous.

PARTICIPANTS OF THE FOCUS GROUP

<table>
<thead>
<tr>
<th>SEGMENT</th>
<th>PARTICIPANT(S)</th>
</tr>
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</table>
| Academia                | University of Johannesburg  
Dr. Suretha de Kock (Senior Lecturer)  
Email: surethad@uj.ac.za |
| Retailers               | Pick n’ Pay  
Denise Engelbrecht (Technical Manager Private Label)  
Email: denisee@pnp.co.za |
| Dairy Sector            | SA Milk Processors Organization, SAMPRO  
Gerhard Venter  
Email: gerhard@sampro.co.za |
| Meat Sector             | No representative                                                                                           |
| Beverage Sector         | The South African Breweries Limited  
Ezaan de Lange (Learning & Development Consultant: Skills Development)  
Email: Ezaan.Delange@za.sabmiller.com  
Naresh Nagin (Learning & Development Specialist)  
Email: Naresh.Nagin@za.sabmiller.com  
ABI : Satish Harrichand  
Email Satish.Harrichand2@za.sabmiller.com |
| Food Manufacturing Sector | Liz Waite (Innovation Manager: Snackworks)  
Email: LizW@snackworks.co.za |
| Food Safety Specialist  | Thea Laufs (FSMS Auditor: LTL Group of Companies)  
Email: thea@ltlconsultants.co.za |
<table>
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<tr>
<th>SEGMENT</th>
<th>PARTICIPANT(S)</th>
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<tbody>
<tr>
<td>Food Ingredients Suppliers</td>
<td><strong>Stacey Brameld</strong> <em>(CellChem)</em>&lt;br&gt;Email: <a href="mailto:stacey@cellchem.co.za">stacey@cellchem.co.za</a></td>
</tr>
<tr>
<td>Food Product Development Specialist</td>
<td><strong>Helena Otto</strong> <em>(Future Food Technologies: Technical Director)</em>&lt;br&gt;Email: <a href="mailto:helena@fftech.co.za">helena@fftech.co.za</a></td>
</tr>
<tr>
<td>Government Stakeholders</td>
<td><strong>Ms Maryke Herbst</strong> <em>(Assistant Director: Food Control)</em>&lt;br&gt;Email: <a href="mailto:herbsm@health.gov.za">herbsm@health.gov.za</a></td>
</tr>
<tr>
<td></td>
<td>Dept. of Agriculture, Forestry &amp; Fisheries, Chief Directorate: Inspection &amp; Quarantine Services, Directorate: Food Safety &amp; Quality Assurance&lt;br&gt;&lt;strong&gt;Mr Theo van Rensburg / Mr Neil Erasmus&lt;/strong&gt; <em>(Manager: Division Animal &amp; Processed Products)</em>&lt;br&gt;E-mail: <a href="mailto:theovr@daff.gov.za">theovr@daff.gov.za</a> / <a href="mailto:neile@daff.gov.za">neile@daff.gov.za</a></td>
</tr>
<tr>
<td>SAAFoST representative</td>
<td><strong>Nigel Sunley</strong>&lt;br&gt;Sunley Consulting – Technical Consultancy to the Food Industry&lt;br&gt;Email: <a href="mailto:nigel@sunleyconsulting.co.za">nigel@sunleyconsulting.co.za</a></td>
</tr>
<tr>
<td>South African Association of the Flavour and Fragrance Industry (SAAFFI) representative</td>
<td><strong>Sharon Bolel</strong> <em>(SAAFFI: Assistant Executive Director)</em>&lt;br&gt;Email: <a href="mailto:sharon@saffi.co.za">sharon@saffi.co.za</a>&lt;br&gt;Tel: +27 (0)11 447 2757&lt;br&gt;Mobile: +27 (0)83 449 2696</td>
</tr>
</tbody>
</table>

**ETHICS AND CONFIDENTIALITY**

Ethical clearance for this study has been granted by the UJ Faculty of Education’s Ethical Committee. There is unlikely to be any discomfort associated with being a participant in the focus group. The voice recording will be stored as a password protected file for a period of two years. The transcribed voice recording will be used for content analysis and this will also be securely stored, and password protected. The participants of the focus group will not be identified in the transcription or in the subsequent online survey.

The decision to take part in this focus group is voluntary and remains your choice. You may withdraw your consent to participate at any time with no consequence to you.
ANNEXURE F: The final questionnaire

QUESTIONNAIRE TO BE ADMINISTERED AS A WEB-BASED SURVEY

The specific attributes required of food science and technology graduates from South African higher education institutions

INTRODUCTION TO THE SURVEY

This 30 – 35 minutes survey questionnaire will collect data to identify the most important employability attributes required of food scientists and food technologists on entering employment for the first time after graduating from a South African (SA) Higher Education Institution (HEI). The data collected will be used to develop a graduate profile based on the essential graduate attributes identified against which the employability attributes of the current graduates can be measured in order to identify potential gaps. The ultimate aim is to make use of the data and information collected to improve the employability and work readiness of food science and food technology graduates from SA HEIs and increase the general level of service delivery to the graduates and the SA stakeholder community.

The survey has six sections, namely:

- General information.
- Employability (general employment) skills e.g. communication, team work, etc.
- Personal attributes required of food scientists and/or technologists.
- Broad food science and/or food technology disciplinary understanding and skills (cognitive and technical skills)
- Sector-specific food science and/or food technology disciplinary understanding and skills
- General comments and work placement

The responses to the survey will be anonymous and treated as confidential. Once you have completed the survey, you will be asked if you are willing to take part in the next phase of the research study which is to determine to what extent the current food
science and food technology graduates are demonstrating the employability attributes identified in the survey.

You are under no obligation to complete this questionnaire and may stop doing so at any stage in which case your responses will be excluded. However, you are encouraged to complete the whole questionnaire and submit it so that your voice is heard.

**PLEASE NOTE**

According to the revised National Qualifications Sub-Framework, the SA Department of Higher Education and Training has made no provision for the B. Tech. qualification. The B. Tech. in Food Technology will be phased out and replaced with the Advanced Diploma (undergraduate) and Postgraduate Diploma in Food Technology or a 4 year Bachelor's degree. **For the purpose of this survey, the B. Tech. Food Technology will be considered as an undergraduate qualification.** The data collected will assist with the development of the curricula and content for the new qualifications.

There are 78 questions in this survey.

**REFERENCES (Not included in survey – for own use only)**


SECTION 1: DEMOGRAPHICS AND GENERAL

1.1 Gender
   o Male
   o Female
   o Prefer not to indicate

1.2 Select the choice that best corresponds to your highest level of education.
   Please choose only one of the following:
   o Never graduated from high school
   o Matriculated from high school with a Grade 12 or equivalent.
   o Matriculated from high school and registered as a full-time student.
   o Graduated with higher education qualification/s in food science and/or food technology. Link → Comment box
   o Graduated with higher education qualifications in food science and/or technology in addition to post school and/or higher education qualifications in other disciplines. Link → Comment box
   o Graduated with post school and/or higher education qualifications other than food science and/or technology. Link → Comment box

Comment box: Please provide the name/s of your qualification/s and the institution/s (and country if outside South Africa) from which you graduated

1.3 What best describes your current employment status?
   o Not employed and seeking employment.
   o Retired.
   o Disabled, not able to work.
   o Registered as a full-time food science or technology student at a SA higher education institution. Link → End of the survey.
   o Employed as an intern food scientist and/or work integrated learning food technology student as a requirement to graduate. Link → End of the survey.
- Employed within the SA private sector within the food, beverage and related industries.
- Employed and registered for part-time studies in food science and/or technology.
- Employer of food scientists and/or technologists within the SA private sector in food, beverage and related industries.
- Employed in the private sector other than food, beverage and related industries.
- Employed full- or part-time at a higher education institution.
- Employed within in the public sector e.g. government department, etc.
- Not formally employed, self-employed and/or a consultant within the food, beverage and related industries.
- Other (please specify) Text box.

1.4 If applicable, please provide your current job title and a short description of your job or level of involvement in the food, beverage and/or related industries. Text box.

1.5 Indicate the geographical area in which you mainly reside and/or are employed.
- Eastern Cape
- Free State
- Gauteng
- Kwazulu Natal
- Limpopo / Northern province
- Mpumalanga
- North West Province
- Northern Cape
- Western Cape
- Other (please specify) __________
1.6 What is your total years of work experience/employment?
Please choose only one of the following:
- Not applicable/no experience. Link → End of the survey.
- Work integrated learning (in-service) employment only to meet the requirements for graduation. Link → End of the survey.
- Newly graduated and employed as an intern or undergoing further training e.g. on a company graduate program. Link → End of the survey.
- Employed for less than one year. Link → End of the survey.
- Employed for 1 to 5 years.
- Employed for 6 to 10 years.
- Employed for 11 to 15 years.
- Employed for more than 15 years.

1.7 In which of the following employment sectors do you have a minimum of one year of experience?
Please choose all that apply.
- Not applicable.
- Government. Link →

In which department and directorate are you employed (optional):
__________________________
__________________________
- Agriculture and primary processing.
- Food, beverage and/or related industries.
- Technical sales (e.g. ingredients, additives, equipment, cleaning chemicals, etc.) to food, beverage and/or related industries.
- Applied research and development and/or new product/process development including flavourists and application technologists.
- Academia and/or pure research.
- Retail sector.
- Packaging sector.
- Food safety and quality including as a consultant and/or auditor.
- Food regulatory and scientific matters other than government.
- Other (please specify): ____________
1.8 In which of the following areas within the food, beverage and related industry have you been active for one year or more.

Please choose all that apply.

- Not applicable
- Dairy (milk, milk products, cheese, yoghurt, etc.).
- Cereals grains and baked goods.
- Snack products
- Alcoholic and other beverages, excluding dairy.
- Fruit and vegetable – fresh and/or processed.
- Meat – fresh and/or processed.
- Poultry – fresh and/or processed.
- Fish and seafood – fresh and/or processed.
- Fats and oils including products such as margarine.
- Sugar and confectionery including chocolate.
- Ingredients manufacturing, sales and/or supply.
- Other (please specify): ____________

SECTION 2: EMPLOYABILITY/EMPLOYMENT SKILLS

Please rate the importance of the following employability attributes or employment skills that in your opinion may be expected from food scientists and/or technologists on taking up employment for the first time after graduating. This does not include students placed for work integrated learning and/or internships which are a requirement in order to graduate as this is considered essential to the development of these skills.

Responses collected by rating perceived level of importance through a 6 Point Likert scale –

<table>
<thead>
<tr>
<th>1*</th>
<th>2*</th>
<th>3*</th>
<th>4*</th>
<th>5*</th>
<th>6*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all important</td>
<td>Low importance</td>
<td>Slight importance</td>
<td>Moderately important</td>
<td>Very important</td>
<td>Extremely important</td>
</tr>
</tbody>
</table>

* Not visible to the participants
2.1 GENERAL EMPLOYABILITY SKILLS

Rate the importance of the following general employability skills. Please choose the appropriate response for each item:

2.1.1 Effective reading including recognition and retention of key points/details/facts and interpretation of what is being read.

2.1.2 Numeracy and mathematical skills demonstrated through the ability to use numbers, fractions and percentages at an appropriate level of accuracy.

2.1.3 Computer literacy as demonstrated through the ability to use appropriate computer software.

2.1.4 Information retrieval through the ability to access different sources of information.

2.1.5 Organisational skills including attention to detail, coordination of activities, effective administration and the ability to approach tasks in a structured, methodical manner.

2.1.6 Other – please specify) general employability skills of importance?

2.2 COMMUNICATION SKILLS:

2.2.1 Rate the importance of the following general written communication skills. Please choose the appropriate response for each item:

2.2.1.1 Organising ideas in writing appropriate to the reader and situation.

2.2.1.2 Creating and using appropriate language and document format e.g. reports and manuals.

2.2.1.3 Recording and reporting information completely and correctly.

2.2.1.4 Anticipating and eliminating sources of potential confusion in written communication.

2.2.1.5 Checking, editing and revising documents for correct information, appropriate emphasis, grammar, spelling and punctuation.
2.2.1.6 Using **e-mails** effectively and appropriately for written communication.

2.2.2 Rate the importance of the following general verbal communication skills.

Please choose the appropriate response for each item:

2.2.2.1 **Clear, confident and effective oral communication** to an individual or group in both formal and informal situations.

2.2.2.2 **Listening skills** through responding in a manner that shows understanding of what has been said.

2.2.2.3 **Sensitivity** to factors such as political, cultural, disability and gender issues when verbally communicating to an individual or group.

2.2.2.4 Using the **appropriate level of verbal communication** to the listener and situation including communicating technical information to a non-technical audience.

2.2.2.5 Demonstrating professional **telephone etiquette**.

2.2.3 Indicate from the list below the primary/most important language/s in which communication skill is required.

You may select more than one.

- Afrikaans
- English
- Ndebele
- Northern Sotho
- Sotho
- Swazi
- Tsonga,
- Tswana
- Venda
- Xhosa
- Zulu
- Other – please specify: ____________________
2.2.3.1 Other (please specify) general communication skills of importance?

___________________________________________________________

2.3 LEADERSHIP AND MANAGEMENT SKILLS

Rate the importance of the following management skills and leadership.

2.3.1 Teamwork including the ability to work constructively as a team member.
2.3.2 Leadership and/or potential leadership qualities within a variety of activities and situations.
2.3.3 Unifying diverse opinions within the workplace.
2.3.4 Encourage, motivate and mentor others.
2.3.5 Self-management and the ability to multi-task.
2.3.6 Prioritising, setting goals and planning a structured course of action to achieve goals by ranking tasks according to importance.
2.3.7 Working efficiently with a high level of effort and in a structured manner.
2.3.8 Effective time management and meeting deadlines.
2.3.9 Decision-making skills including generating and weighing up different alternatives, identifying the best option to achieve the desired goal and implementing the decision.
2.3.10 Managing and resolving conflicts in the workplace.
2.3.11 Present facts and arguments to justify a position.
2.3.12 Critical thinking to deconstruct a problem or situation and develop solutions to solve the problem.
2.3.13 Project planning and scheduling and the ability to delegate tasks to meet a goal.
2.3.14 Commercial awareness, understanding and integrating business purposes, issues and priorities including the meaning of work, productivity and productivity improvement and quality management.
2.3.15 Coping with complexity and handling complex and ambiguous situations including managing ill-defined situations and problems.
2.3.16 Adaptability and flexibility to respond to changing circumstances and new challenges.
2.3.17 **Problem-solving** including identifying problems, creating, identifying and implement solutions to correct a problem and evaluating the effectiveness of the solution/s with a view to implement further improvements.

2.3.18 **Entrepreneurial skills** (business, tactical, innovative and risk-taking) to pursue opportunities outside of the formal job market.

2.3.19 **Managing work pressures** effectively.

2.3.20 **Other** (please specify) leadership and management skills of importance?

________________________________________________________________________

2.4 **DIVERSITY MANAGEMENT SKILLS**

Rate the following diversity management skills.

2.4.1 **Understand cultural and gender differences** and take them into consideration when managing situations in the workplace.

2.4.2 **Being politically sensitive**.

2.4.3 **Interact constructively with people** having different ethnic, social and educational backgrounds.

2.4.4 **Considerate** of the concerns and positions of different ethnic, social and gender groups and people with disabilities.

2.4.5 **Other** (please specify) diversity management skills of importance?

________________________________________________________________________

2.4.6 Please provide additional comments on the **employability attributes** which you would expect on employing a food scientist and/or food technologist.

________________________________________________________________________

**SECTION 3: PERSONAL ATTRIBUTES**

Personal attributes for the purpose of this study include personal qualities, dispositions, emotional intelligence and intellectual skills. Please rate the importance of the following that you would expect from a food scientist and/or food technologist when taking up employment for the first time after graduating.
<table>
<thead>
<tr>
<th>1*</th>
<th>Not at all important</th>
<th>2*</th>
<th>Low importance</th>
<th>3*</th>
<th>Slight importance</th>
<th>4*</th>
<th>Moderately important</th>
<th>5*</th>
<th>Very important</th>
<th>6*</th>
<th>Extremely important</th>
</tr>
</thead>
</table>

* Not visible to the respondents

3.1 **Positive attitude** and belief that attributes e.g. intelligence and attitudes can be continually developed.

3.2 **Perseverance, resilience and adaptable** to changing situations.

3.3 **Self-aware** of own strengths, weaknesses, aims and values.

3.4 **Confidence** in dealing with challenges in an assertive, firm and positive manner.

3.5 **Self-motivated** and **demonstrate initiative**.

3.6 **Work independently** with little supervision.

3.7 **Take action and/or informed risks** without prompting when dealing with challenges.

3.8 Display **high energy with a 'can do' approach**, take on tasks, set goals and continually enhance work performance level.

3.9 Show **sensitivity, respect and empathy** towards the feelings and positions of others.

3.10 Be **humble and grounded**.

3.11 **Accept criticism** without retaliating negatively.

3.12 **Manage stress** through demonstrating the ability to retain effectiveness under pressure.

3.13 **Intellectual curiosity, eagerness to learn and commitment to ongoing learning** to meet the needs of employment and life including the ability to identify opportunities for life-long learning and learn new skills as required by the workplace.

3.14 **Common-sense and logical approach** to society and the workplace including the ability to analyse/solve problems and reflect on and evaluate situations and own performance.

3.15 **Professionalism** including presenting a positive personal image.

3.16 **Global awareness** in terms of general knowledge.

3.17 **Occupational awareness** including nurturing the company culture and enthusiasm for food science and technology.
3.18 Ethical sensitivity and integrity including trustworthiness and behaving honestly and fairly, making positive use of rules and/or values and exhibiting good work ethics.

3.19 Likeability including a warm, friendly and cooperative manner.

3.20 The resolve to take risks, accept challenges and speak up in difficult situations.

3.21 Ambition to better own circumstances.

3.22 Creativity and the ability to be original, inventive and to apply lateral thinking.

3.23 Accountable and responsible including the ability to admit to mistakes and accept and carry out instructions in a constructive manner.

3.24 Pay attention to detail and like to do things properly.

3.25 Other (please specify) personal attributes you consider important?

______________________________________________________________

3.26 Please add any general comments you may have with regard to the personal qualities, attributes, dispositions, emotional intelligence and intellectual skills you would expect on employing a food scientists and/or food technologist.

______________________________________________________________

SECTION 4:
FOOD SCIENCE AND/OR FOOD TECHNOLOGY DISCIPLINARY UNDERSTANDING AND SKILLS (COGNITIVE AND TECHNICAL SKILLS)

Undergraduate qualifications in food science and technology aim to produce graduates with strong fundamental food science and technology academic and professional understanding, skills and competencies. This section will probe what is required from food science and/or food technology graduates when taking up employment for the first time.

4.1 Please indicate which category best describes you:
   o Food scientist
   o Food technologist
   o Other
In your opinion, rank the importance of the following fundamental food science and technology academic and professional understanding, skills and competencies required of Food Scientists on graduating and taking up employment for the first time. Rate the least important as 12 the most important as 1.

Double-click and drag-and-drop items in the left list to move them to the right – your highest-ranking item should be on the top right moving through to your lowest ranking item.

### Table 4.1 Food Scientists

<table>
<thead>
<tr>
<th>Fundamental food science and technology academic and professional understanding, skills and competencies.</th>
<th>Food Scientist</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food analysis (analytical, biochemical and chemical)</td>
<td></td>
</tr>
<tr>
<td>2. Sensory analysis</td>
<td></td>
</tr>
<tr>
<td>3. Food chemistry</td>
<td></td>
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<tr>
<td>4. Nutrition</td>
<td></td>
</tr>
<tr>
<td>5. Food regulation and control including legislation</td>
<td></td>
</tr>
<tr>
<td>6. Food microbiology, general microbiology and microbial analysis</td>
<td></td>
</tr>
<tr>
<td>7. Food packaging</td>
<td></td>
</tr>
<tr>
<td>8. Food processing (heat processing, freezing, etc.)</td>
<td></td>
</tr>
<tr>
<td>9. Food engineering (mass balances, calculations, etc.)</td>
<td></td>
</tr>
<tr>
<td>10. Food product development</td>
<td></td>
</tr>
<tr>
<td>11. Food safety and quality management</td>
<td></td>
</tr>
<tr>
<td>12. Applied food science and technology</td>
<td></td>
</tr>
</tbody>
</table>

In your opinion list five employability attributes (general and discipline specific) that are essential to a food scientist in order to take up employment for the first time after graduating.
In your opinion, rank the importance of the following fundamental food science and technology academic and professional understanding, skills and competencies required of Food Technologists on graduating and taking up employment for the first time. Rate the least important as 12 the most important as 1.

Double-click and drag-and-drop items in the left list to move them to the right – your highest-ranking item should be on the top right moving through to your lowest ranking item.

Table 4.2: Food Technologists

<table>
<thead>
<tr>
<th>Fundamental food science and technology academic and professional understanding, skills and competencies.</th>
<th>Food Technologist</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food analysis (analytical, biochemical and chemical)</td>
<td></td>
</tr>
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<td></td>
</tr>
<tr>
<td>12. Applied food science and technology</td>
<td></td>
</tr>
</tbody>
</table>
4.3 In your opinion list five employability attributes (general and discipline specific) that are essential to a food technologist in order to take up employment for the first time after graduating.

<table>
<thead>
<tr>
<th>1 LEAST IMPORTANT</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 MOST IMPORTANT</th>
</tr>
</thead>
</table>

The following questions will provide additional insight into what fundamental understanding, skills and competencies are important to a food scientist and/or technologist on taking up employment. Answers to these questions is optional, however taking the time to complete the questions in this section will provide valuable data and you are encouraged to answer them.

Rate the importance of the following fundamental professional understanding, skills and competencies required of newly graduated Food Scientists and/or Food Technologist. You may differentiate by selecting “S” for a food scientist, “T” for a food technologist; to select the same rating for both, use a cross “X”.

Responses will be rating through a 6 Point Likert scale

<table>
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<tr>
<th>1* Not at all important</th>
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</thead>
</table>

* Not visible to the respondents

4.4 FOOD ANALYSIS (ANALYTICAL, BIOCHEMICAL & CHEMICAL)

Rate the importance of the following food analysis (analytical, biochemical and chemical) understanding, skills and competencies.
4.4.1 Source, select, understand and apply the principles of food analysis methods and/or techniques.

4.4.2 Demonstrate practical proficiency to perform food analysis methods and/or techniques in order to monitor the safety, nutritional value, quality and shelf-life of foods and related products.

4.4.3 Demonstrate practical proficiency in performing food analysis during food product development including determining nutritional values and ensuring product safety, quality and shelf-life.

4.4.4 Perform more advanced methods and techniques to food analysis e.g. chromatography, spectrophotometry, etc.

4.4.5 Make use of molecular techniques for e.g. to confirm food authenticity, species identification, traceability, etc.

4.4.6 Demonstrate appropriate sampling methods including sampling plans, sample preparation and sample handling techniques including sample digestion, solvent extraction, membrane separation.

4.4.7 Determine the quality aspects other than microbiological to determine the shelf-life of products.

4.4.8 Construct a food analysis report recording results of food analysis, interpretation of the results and conclusion/s.

4.4.9 Interpret a food analysis report and take appropriate action.

4.4.10 Other (please specify).

4.4.11 Please add any general comments you may have with regard to analytical, biochemical and chemical food analysis understanding, skills and competencies.

4.5 FOOD ANALYSIS (MICROBIOLOGICAL)

Rate the importance of the following food microbial analysis understanding, skills and competencies.
4.5.1 Understand the principles, source, select and perform microbial methods and/or techniques to identify and enumerate microorganisms in foods and related products.

4.5.2 Make use of rapid microbiological methods and/or techniques to e.g. monitor safety and quality of foods and monitor the effectiveness of cleaning and sanitation.

4.5.3 Demonstrate practical proficiency when performing microbial analysis.

4.5.4 Source, select and perform microbial analysis to determine the expected microbial shelf-life of food and related products.

4.5.5 Construct a food microbial analysis report to record results of analysis, interpret results and draw conclusions.

4.5.6 Conduct microbial molecular techniques such as Polymerase Chain Reaction (PCR), gel electrophoresis, DNA microarrays, to detect microorganisms in foods.

4.5.7 Other (please specify).

4.5.8 Please add any general comments you may have related to microbial food analysis understanding, skills and competencies.

4.6 SENSORY ANALYSIS

Rate the importance of the following sensory analysis understanding, skills and competencies.

4.6.1 Identify, select and conduct appropriate sensory analysis methods for different applications including quality control and assurance, new product development, and shelf-life studies.

4.6.2 Collect, analyse and interpret the data and results collected using different sensory analysis methods.

4.6.3 Make use of Good Sensory Laboratory Practices when conducting sensory analysis.

4.6.4 Other (please specify).
4.6.5 Please add any general comments you may have related to sensory analysis understanding, skills and competencies.

4.7 FOOD CHEMISTRY

Rate the importance of the following food chemistry understanding, skills and competencies.

4.7.1 Identify the functional properties of food components within foods and select food ingredients to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life).

4.7.2 Describe the structure and apply the chemistry of food components to deliver the required product attributes (sensory, nutritional, safety, quality and shelf-life) during processing, storage, distribution and sale.

4.7.3 Apply knowledge to interpret results from food analysis in order to measure, control, modify and improve the required product attributes.

4.7.4 Other (please specify).

4.7.5 Please add any general comments you may have related to food chemistry understanding, skills and competencies.

4.8 NUTRITION

Rate the importance of the following nutrition understanding, skills and competencies.

4.8.1 Outline the fundamentals of human nutrition and describe the nature of foods, food selection and food groups in nutrition.
4.8.2 Identify how nutrients in food impact health and wellness positively and negatively including sugar (obesity, heart disease, and diabetes), salt (hypertension, cardiovascular disease), dietary fats and other additives.

4.8.3 Identify the nutritional requirements of different population groups in terms of energy, health and wellness to order to avoid under- or over-nutrition and apply this knowledge in new product development.

4.8.4 Understand and apply knowledge of food allergies in all areas of food manufacture from product development and selection of ingredients through production, packaging and labelling.

4.8.5 Explain bioavailability, compatibility and the physiological aspects of nutrients in nutrition including vitamins and minerals and apply this in food manufacture from product development and selection of ingredients through production, packaging and labelling.

4.8.6 Identify the effects of food processing methods on the nutritional qualities of foods and apply knowledge to minimise nutritional losses.

4.8.7 Understand and apply nutrition principles to food product development and food formulation and develop a correct nutritional table to appear on a product label

4.8.9 Other (please specify).

4.8.10 Please add any general comments you may have regarding nutrition understanding, skills and competencies.

4.9 FOOD REGULATION AND CONTROL

Rate the importance of the following food regulation and control understanding, skills and competencies.

4.9.1 Describe the scope, application and influence of global and national food regulation and control initiatives.

4.9.2 Locate global food safety and quality codes of practice, guidelines and related documentation e.g. Codex documentation.
4.9.3 Demonstrate understanding of food regulation and control in the Republic of South Africa (SA) and locate, interpret and apply relevant SA legislation that regulates the safety and quality of agricultural, food and beverage products from product and formulation development through manufacturing, packaging, labelling, distribution and sale.

4.9.4 Critique a food product label against the SA legislative requirements and/or develop a food label that meets the requirements of SA legislation.

4.9.5 Other (please specify) _______________________________________________________

4.9.6 Please add any general comments you may have on food regulation and control understanding, skills and competencies.

________________________________________________________

4.10 FOOD MICROBIOLOGY

Rate the importance of the following microbiology and food microbiology understanding, skills and competencies.

4.10.1 Classify and describe microorganisms including those that can be used to produce fermented foods, influence microbial safety i.e. pathogens causing foodborne illness and quality in foods i.e. spoilage organisms.

4.10.2 Demonstrate learning of the role and significance of intrinsic (pH, aw, nutrients, etc.) and environmental/extrinsic parameters (temperature of storage, atmosphere of storage, etc.) and apply this knowledge to promote microbial growth e.g. fermented foods, destroy microorganisms and/or inhibit microbial growth.

4.10.3 Understand the factors that lead to foodborne illness and implement strategies and systems to prevent/limit the incidence of foodborne illness.

4.10.4 Manipulate parameters and apply microbial and processing knowledge of food preservation techniques such as pasteurisation, heat sterilisation, irradiation, freezing, etc. to ensure the microbial stability and safety of foods and related products.
4.10.5 Describe and predict the microbial spoilage patterns of foods and related products and implement strategies and systems to obtain the required shelf-life.

4.10.6 Develop microbiological criteria or specifications for raw materials and finished products.

4.10.7 Other (please specify).

4.10.8 Please add any general comments you may have related to microbiology and food microbiology understanding, skills and competencies.

4.11 FOOD PACKAGING

Rate the importance of the following food packaging understanding, skills and competencies.

4.11.1 Identify the basic properties and uses of various packaging materials and compare and select appropriate packaging systems to meet requirements including product safety, quality, preservation, convenience, marketing, consumer needs, etc.

4.11.2 Identify new and innovative packaging materials and packaging technologies and assess their applicability to existing products and new product development.

4.11.3 Evaluate the sustainability and environmental aspects of packaging materials and apply this to minimize waste and limit environmental impact.

4.11.4 Design and develop a food package prototype in new food product development and conduct experiments to validate a packaging system or material is meeting the requirements of the product.

4.11.5 Other (please specify).

4.11.6 Please add any general comments you may have related to packaging understanding, skills and competencies.
4.12 FOOD PROCESSING

Rate the importance of the following food processing understanding, skills and competencies.

4.12.1 Describe the source and variability of raw food materials and select suitable raw food materials for various food processing and preservation operations.

4.12.2 Identify the spoilage and deterioration mechanisms in foods and apply the food processing and preservation principles to increase shelf-life, retain sensory, quality and nutritional properties and produce safe food products.

4.12.3 Demonstrate learning of the unit operations generally associated with food processing e.g. mixing, extrusion, heat processing and preservation, freezing, dehydration, evaporation, etc. and select the unit operations required to develop a process flow to produce a given food product.

4.12.4 Evaluate the requirements for water utilization and waste management in food processing factories.

4.12.5 Determine the effects of processing parameters on product safety and quality.

4.12.6 Design and maintain time and production schedules/records.

4.12.7 Other (please specify).

4.12.8 Please add any general comments you may have related to food processing understanding, skills and competencies.

4.13 FOOD ENGINEERING

Rate the importance of the following food engineering understanding, skills and competencies.

4.13.1 Classify forms of energy and apply the properties of different energy sources, air and water to manage energy requirements of processing operations.
4.13.2 Apply knowledge of the sustainability and environmental issues around the use of energy including energy conservation and waste recovery.

4.13.3 Interpret and apply the concepts of material (mass) and energy balances in food processing systems.

4.13.4 Determine material (mass) and energy balances for a given processing operation and apply this to understanding profitability.

4.13.5 Make use of software programs e.g. Excel spreadsheets to calculate and analyse material (mass) and energy balances.

4.13.6 Determine optimal design factors and operating conditions for food manufacturing operations e.g. pasteurization, canning, dehydration, cooling, etc. in order to obtain the required product attributes.

4.13.7 Describe and apply the physics of fluid flow as related to food processing systems.

4.13.8 Other (please specify).

4.13.9 Please add any general comments you may have related to food engineering understanding, skills and competencies.

4.14 **FOOD PRODUCT DEVELOPMENT**

Rate the importance of the following food product development understanding, skills and competencies.

4.14.1 Research current trends and new ingredients, process technologies and packaging to develop new product concepts and prototypes and/or improve existing products.

4.14.2 Identify and define the target market needs, wants and requirements in order to develop the required product attributes for a new food product.

4.14.3 Identify and screen product ideas and follow a structured product development process to develop a product prototype.
4.14.4 Develop new or modify existing food products by sourcing and selecting raw materials and other ingredients and developing product formulations and processing strategies.

4.14.5 Manipulate formulation input costs to meet product target selling price and prepare total product costings including variable and fixed costs to meet a project brief.

4.14.6 Design safety and quality into new or existing food products through raw material/ingredient selection, process flow development, determining the process parameters, packaging, etc.

4.14.7 Determine the shelf-life of product prototypes during the development process.

4.14.8 Conduct production scale-up and troubleshoot at the start-up of manufacture of a food product.

4.14.9 Other (please specify). ____________________________________________________________

4.14.10 Please add any general comments you may have related to food product development understanding, skills and competencies.

4.15 FOOD SAFETY AND QUALITY MANAGEMENT

Rate the importance of the following food safety and quality management understanding, skills and competencies.

4.15.1 Develop and apply Food Safety Objectives to ensure food safety and quality.

4.15.2 Understand, select and apply appropriate principles and tools to food quality control and assurance in order to monitor and improve the safety and quality of foodstuffs and related products.

4.15.3 Develop, implement and evaluate existing Prerequisite Programmes (PRPs) e.g. pest control, personal hygiene, cleaning and sanitation, etc. within the food and related industries.

4.15.4 Understand and apply knowledge when planning and/or evaluating food processing plant location, building structures, services (water, air, steam, etc.) and materials of construction and apply principles of food safety and quality to the layout, flow and area zoning within a food processing facility.
4.15.5 Apply the principles and practices of cleaning and sanitation in food processing operations including CIP systems.

4.15.6 Demonstrate learning of the hygienic design and materials of construction of food processing equipment and apply this when selecting new processing equipment and/or evaluating existing equipment.

4.15.7 Conduct a risk analysis as part of a food safety and quality management system such as Hazard Analysis Critical Control Points (HACCP).

4.15.8 Demonstrate learning and apply principles of Hazard Analysis Critical Control Points (HACCP) and develop a HACCP plan as part of a team.

4.15.9 Ability to validate food processing parameters selected for the monitoring and management of food safety and quality.

4.15.10 Interpreting verification data from monitoring and analysis e.g. chemical, microbiological, etc. to verify that processing parameters are performing as intended.

4.15.11 Other (please specify).___________________________________________

4.15.12 Please add any general comments you may have related to food safety and quality understanding, skills and competencies.________________________________________________________

4.16 APPLIED FOOD SCIENCE AND TECHNOLOGY

Rate the importance of the following applied food science and technology understanding, skills and competencies.

4.16.1 Apply and incorporate the principles of food science in practical, real-world situations and problems.

4.16.2 Select and compile experimental designs and apply statistical principles to food science and technology applications.

4.16.3 Interpret statistical analysis of data and recommend appropriate action.

4.16.4 Replace existing ingredients within a food formulation to e.g. cut costs or improve quality.

4.16.5 Other (please specify).___________________________________________
Please add any general comments you may have related to applied food science and technology understanding, skills and competencies.

SECTION 5: SECTOR-SPECIFIC FOOD SCIENCE AND/OR FOOD TECHNOLOGY DISCIPLINARY UNDERSTANDING AND SKILLS (COGNITIVE AND TECHNICAL SKILLS)

Specialised areas of food science and technology/manufacture include fruits and vegetables, fisheries, milk and dairy, grains, baked goods, meat, poultry, alcoholic beverages (fruit wine, malt beer), non-alcoholic beverages, fermented products, etc. Specialisation into these areas is often the focus of postgraduate studies. This section is to probe broad sector-specific learning required within an undergraduate qualification to meet the expectations of SA stakeholders.

Rate the importance of the following broad sector-specific professional understanding, skills and competencies required of newly graduated Food Scientists and/or Food Technologists.

<table>
<thead>
<tr>
<th>1* Not at all important</th>
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</tr>
</thead>
</table>

* Not visible to the respondents

(THE HEADINGS ARE NOT VISIBLE TO THE RESPONDENTS)

PROCESSED AND PRESERVED PRODUCTS

5.1 Fresh and processed meat products
5.2 Fresh and processed poultry products
5.3 Fresh and processed fish and fish products
5.4 Fresh and processed fruit and vegetables
5.5 Vegetable and animal fats and oils

**DAIRY PRODUCTS**
5.6 Milk and milk products e.g. pasteurised and UHT milk, milk powders, concentrated milk products.
5.7 Dairy products e.g. butter, hard cheeses, soft cheeses, yoghurt, ice-creams.

**MANUFACTURE OF FOOD PREPARATION PRODUCTS**
5.8 Grain mill products.
5.9 Starches and starch products.
5.10 Prepared animal feeds.

**BAKING, CEREALS, CONFECTIONERY AND SNACKS MANUFACTURING**
5.11 Baked wheat flour products including baked bread, confectionery and snacks e.g. pretzels.
5.12 Sugar and sugar confectionery.
5.13 Cocoa and chocolate manufacture.
5.14 Pasta, couscous and similar products.
5.15 Snack products other than baked wheat flour snacks.

**BEVERAGE MANUFACTURING**
5.16 Tea, coffee and hot beverages such as hot chocolate.
5.17 Distilled spirit products and liqueurs.
5.18 Wine products.
5.19 Malt, malt liquors and malt beers.
5.20 Soft drinks and mineral water both carbonated and still.
5.21 Other (please specify).

5.22 Please add any general comments you may have regarding sector-specific understanding, skills and competencies which are required of undergraduate food scientists and/or technologists on taking up employment for the first time after graduating.
6 OPINION QUESTIONS

6.1 In your understanding, differentiate between a food scientist and food technologist and what each should be able to do when entering work for the first time after graduating.

6.2.1 In your opinion how useful is a period of work integrated learning, ‘in-service’, work experience or service learning in developing the required employability attributes of food scientists and/or technologists.

   o Essential or very useful. Link to questions below
   o Undecided. Link to questions below
   o Not at all useful. Link to the end of the survey

6.3 Provide comments on the usefulness of work integrated learning, ‘in-service’, work placement or service learning period.

6.4 In your opinion, what are the skills acquired during the work integrated learning, ‘in-service’, work placement or service learning?

6.5 In your opinion indicate the required period (in weeks or months) of work integrated learning, ‘in-service’, work placement or service learning required prior to graduating for a:

   o Food scientist. Link to comment box to record period
   o Food technologist. Link to comment box to record period
Thank you for taking the time and effort to complete this online survey, the results of which will be made available to you on analysis of the data.

Please indicate if you would be prepared to be interviewed in regard to this research study by completing your contact details below and indicate the capacity in which you wish to be interviewed:

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact email</td>
<td></td>
</tr>
<tr>
<td>Contact telephone number</td>
<td></td>
</tr>
<tr>
<td>Contact mobile number</td>
<td></td>
</tr>
</tbody>
</table>

Please indicate the capacity in which you would be prepared to be interviewed by placing a X next to one of the choices below:

- Student who expects to complete the last outstanding modules in November 2015 for graduation in early 2016.
- Newly graduated (less than 2 years) and employed food scientist and/or technologist.
- Experienced (more than 2 years) food scientist and/or technologist.
- Employer, supervisor, co-worker and/or manager of food scientists and/or technologists.
- Involved with graduate / internship programs for food science and/or technology graduates.
- Consultant to the food industry.
- Other, (please specify).
ANNEXURE G: E-mail invites to respond to the web-based survey

1. Initial e-mail invite addressed to SAAFoST members to respond to the online survey: 12.08.2015

Dear SAAFoST member,

In an effort to identify the **employability attributes required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI)**, I am conducting a research study with SAAFoST members as the target audience. Your input by completing the online survey can assist to identifying the employability attributes essential to food scientists and food technologists taking up employability for the first time after graduating. The results obtained will be used to measure the employability attributes of the current graduates and identify potential gaps. The ultimate aim is to make use of the data and information collected to **improve the employability and work readiness of food science and food technology graduates from SA HEIs and increase the general level of service delivery to the graduates and the SA stakeholder community**.

I estimate that it will take you approximately 30 – 40 minutes to complete the survey. So please make yourself a cup of tea or coffee before starting!

Simply click on the link below, or cut and paste the entire URL into your browser to access the survey: [https://g3research.co.za/index.php/171496](https://g3research.co.za/index.php/171496)

I would appreciate your response by **26 August**.

Your input is very important and will be kept strictly confidential (used only for the purposes of research for this project).

If you have any questions or would prefer to complete a paper survey please email me at [dmetcalfe@uj.ac.za](mailto:dmetcalfe@uj.ac.za)

Kind regards,

Denise Metcalfe

*Senior Lecturer*
Dept. of Biotechnology and Food Technology
Faculty of Science
University of Johannesburg
Dear [Recipient],

In an effort to identify the employability attributes required of food science and food technology graduates from South Africa (SA) Higher Education Institutions (HEI), I am conducting a research study with SAARoST members as the target audience. Your input by completing the online survey can assist in identifying the employability attributes essential to food scientists and food technologists taking up employability for the first time after graduating. The results generated will be used to measure the employability attributes of the current graduates and identify potential gaps. The ultimate aim is to make use of the data and information collected to improve the employability and work readiness of food science and food technology graduates from SA HEIs, and increase the general level of service delivery to the graduates and the SA stakeholder community.

[Signature]

[Name]

[Position]

[Institution]
Dear Food Industry Professional,

In an effort to identify the **employability attributes (knowledge, skills and competencies including personal attributes)** required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI), I am conducting a research study with food scientists and technologists, employers of food scientists and technologists and other interested stakeholders as the target respondents.

Your input by completing the online survey can assist to identifying the employability attributes essential to food scientists and food technologists taking up employability for the first time after graduating. The results obtained will be used to measure the employability attributes of the current graduates and identify potential gaps. The ultimate aim is to make use of the data and information collected to **improve the employability and work readiness of food science and food technology graduates from SA HEIs and increase the general level of service delivery to the graduates and the SA stakeholder community.**

I estimate that it will take you approximately 30 – 40 minutes to complete the survey. It is long but your input is valuable so please make yourself a cup of tea or coffee before starting!

Simply click on the link below, or cut and paste the entire URL into your browser to access the survey: [https://g3research.co.za/index.php/171496](https://g3research.co.za/index.php/171496)

Your input is very important and will be kept strictly confidential (used only for the purposes of research for this project). My apologies if you receive this request from multiple sources.

If you have any questions or would prefer to complete a paper survey please email me at [dmetcalfe@uj.ac.za](mailto:dmetcalfe@uj.ac.za)

Kind regards,

Denise Metcalfe

**Senior Lecturer**

Dept. of Biotechnology and Food Technology

Faculty of Science
Dear Food industry Professional,

In an effort to identify the employability attributes (knowledge, skills, and competencies) required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEIs), I am conducting a research study with food scientists and technologists, employers of food scientists and technologists, and other interested stakeholders as the target respondents.

Your input by completing the online survey can assist in identifying the employability attributes of the current graduates and identify potential gaps. The ultimate aim of the study is to make use of the data and information collected to improve the employability and work readiness of food science and food technology graduates from SA HEIs and to increase the general level of service delivery to the graduates.

Thank you for your participation.

Sincerely,

[Signature]
3. Second reminder to SAAFoST members: 02.09.2015

Dear SAAFoST member,

Please be reminded to respond to the survey to identify the employability attributes required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI).

Simply click on the link or cut and paste the entire URL into your browser to access the survey: https://g3research.co.za/index.php/171496

It is a long survey - I estimate that it will take you approximately 30 – 40 minutes to complete. So please make yourself a cup of tea or coffee before starting! If you are interrupted or are short of time, hit the button on the bottom left to SAVE AND RESUME LATER. It is only when you hit the SUBMIT button at the end of the survey that your responses are recorded.

Your input is very important and will be kept strictly confidential (used only for the purposes of research for this project). My apologies if you receive this request from multiple sources.

If you have any questions or would prefer to complete the survey at an interview, please email me at dmetcalfe@uj.ac.za so that we can plan to meet.

Kind regards,

Denise Metcalfe

Senior Lecturer
Dept. of Biotechnology and Food Technology
Faculty of Science
University of Johannesburg

DFC, JOB Room 2209B
Tel. +27 11 559 6252
Fax +27 11 559 6651
e-mail dmetcalfe@uj.ac.za
Dear SAARST member,

Please be reminded to respond to the survey to identify the employability attributes required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI).

Display click on the link below, or cut and paste the entire URL into your browser to access the survey:

[URL]

It is a long survey, I estimate that it will take you approximately 30-40 minutes to complete. So please make yourself a cup of tea or coffee before starting. If you are interrupted or are short of time, hit the button on the bottom left to SAVE AND MEASURE LATER. It is very when you hit the SUBMIT button all the end of the survey that your responses are recorded.

Your input is very important and will be kept strictly confidential (used only for the purposes of research for this project). Any apologies if you receive the request from multiple sources.
4. Third reminder to SAAFoST members: 02.09.2015

Dear SAAFoST member,

Many people I chatted to at the SAAFoST Congress run from 07 - 10 September had not yet completed the online survey to identify the **employability attributes required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI)**, which is part of my doctoral research study.

Simply click on the link or cut and paste the entire URL into your browser to access the survey: [https://g3research.co.za/index.php/171496](https://g3research.co.za/index.php/171496)

It is a long survey - I estimate that it will take you approximately 30 – 40 minutes to complete. So please make yourself a cup of tea or coffee before starting! **If you are interrupted or are short of time, hit the button on the bottom left to “SAVE AND RESUME LATER”**. It is only when you **hit the “SUBMIT” button** at the end of the survey that your responses are recorded. The survey has been extended to capture as many responses as possible but will have to close on 18 September so please respond as soon as possible.

Your input is very important and will be kept strictly confidential. If you have any questions or would prefer to **complete the survey at an interview**, please email me at dmetcalfe@uj.ac.za so that we can set up an appointment.

Kind regards,

Denise Metcalfe  
**Senior Lecturer**  
Dept. of Biotechnology and Food Technology  
Faculty of Science  
University of Johannesburg  

DFC, JOB Room 2209B  
Tel. +27 11 559 6252  
Fax +27 11 559 6651  
e-mail dmetcalfe@uj.ac.za
Dear SAAFST Member

Many people I chatted to at the SAAFST Congress ran from 07 -10 September had not yet completed the online survey to identify the employability attributes required of food science and food technology graduates from South African (SA) Higher Education Institutions (HEI), which is part of my doctoral research study.

Simply click on the link or cut and paste the entire URL into your browser to access the survey: https://pipeline.mz.ac.za/index.php?i=66

It is a long survey – I estimate that it will take you approximately 45 -60 minutes to complete. So please make yourself a cup of tea or coffee before starting! If you are interrupted or are short of time, hit the button on the bottom left to “SAVE AND RESUME LATER” – it’s only when you hit the “SUBMIT” button at the end of the survey that your responses are recorded. The survey has been extended to capture as many responses as possible but will have to close on 19 September so please respond as soon as possible.
5. Fourth and final reminder to SAAFoST members: 25.09.2015

URGENT REMINDER: SHOW YOU CARE ABOUT THE EDUCATION OF FOOD SCIENTISTS & TECHNOLOGISTS IN SA BY HAVING YOUR SAY.

THERE HAVE ONLY BEEN 250 COMPLETED SURVEY RESPONSES SUBMITTED OUT OF A POTENTIAL OF 1121 MEMBERS – MORE RESPONSES ARE REQUIRED TO MAKE THIS A MEANINGFUL STUDY.
Student members are excluded from the survey and will have the opportunity for input at a later stage.

Dear Food Industry Professional,

What employability attributes would you like to see in food scientists and food technologists taking up employment for the first time after graduating?

I am conducting an online survey in an effort to identify the employability attributes required of food science and food technology graduates graduating from South African (SA) Higher Education Institutions (HEI). The results obtained will be used to measure the employability attributes of the current graduates and identify potential gaps.

It is a long survey - I estimate that it will take you approximately 35 – 40 minutes to complete. So please make yourself a cup of tea or coffee before starting! If you are interrupted or are short of time, hit the button on the bottom left to “SAVE AND RESUME LATER”. It is only when you hit the “SUBMIT” button at the end of the survey that your responses are recorded.

Simply click on the link or cut and paste the entire URL into your browser to access the survey: https://g3research.co.za/index.php/171496

Your input is very important and will be kept strictly confidential. If you have any questions or would prefer to complete the survey through an interview, please email me at dmetcalfe@uj.ac.za in order to set up a meeting.

Kind regards,

Denise Metcalfe

Senior Lecturer
Dept. of Biotechnology and Food Technology
Faculty of Science
University of Johannesburg
FINAL REMINDER

URGENT REMINDER: SHOW YOUR CARE ABOUT THE EDUCATION OF FOOD SCIENTISTS & TECHNOLOGISTS IN SA BY PAYING YOUR DAY.

THERE HAVE ONLY BEEN 250 COMPLETED SURVEY RESPONSES SUBMITTED OUT OF A POTENTIAL OF 1100 MEMBERS - MORE RESPONSES ARE REQUIRED TO MAKE THIS A MEANINGFUL STUDY.

Student members are excluded from the survey and will have the opportunity for input at a later stage.

Dear Food Industry Professional,

What employability attributes would you like to see in food scientists and food technologists taking up employment for the first time after graduating?

I am conducting an online survey in an effort to identify the employability attributes important to food science and food technology graduates.

Please take a few minutes to complete the survey and help us make a difference in the education of future food professionals. Thank you for your support.

Sincerely,
[Your Name]
ANNEXURE H: South African Association for Food Science and Technology (SAAFoST) membership categories

SAAFoST membership categories

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional members including consultants (10)</td>
<td>An individual who qualifies as a Natural Scientist in food science or related disciplines under the Natural Scientific Professions Act 2003 (Act No 27 of 2003) and/or has applied and been recognised as a professional member by the SAAFoST Council.</td>
</tr>
<tr>
<td>Members</td>
<td>An individual who does not qualify as a professional member but is actively engaged in the field of food science and/or technology.</td>
</tr>
<tr>
<td>Retired members</td>
<td>As for professional and ordinary members above.</td>
</tr>
<tr>
<td>Institution members</td>
<td>Company, institution or organisation active in food science and/or technology, including manufacturers of food, beverages and allied products. Represented by a senior member of staff (preferably scientific and/or technical).</td>
</tr>
<tr>
<td>Custodian members</td>
<td>Selected companies, institutions or organisations actively engaged in FST, invited by SAAFoST Council to ‘subscribe to additional principles in promoting and upholding professional standards of competence and integrity in advancing food science and related technologies for the provision of safe and wholesome food’. Represented by a senior member of staff (preferably scientific and/or technical).</td>
</tr>
<tr>
<td>Honorary life members</td>
<td>Individuals who have made a significant contribution to SAAFoST, identified by Council and elected at a Biannual General Meeting.</td>
</tr>
<tr>
<td>Student members – undergraduate</td>
<td>Registered students of SA HEIs who are registered for undergraduate food science and/or technology programmes.</td>
</tr>
<tr>
<td>Student members – postgraduate</td>
<td>Registered students of SA HEIs who are registered for postgraduate food science and/or technology programmes.</td>
</tr>
</tbody>
</table>

Adapted from: http://www.saafost.org.za/Membership/MembershipCategoriesFees.asp#ClassesOfMembership
ANNEXURE I: Survey participants food sector work experience

Table 1: Food and allied industries categories employment (minimum of one year)

<table>
<thead>
<tr>
<th>Area/s or sectors of food &amp; allied work experience (min. of one year)</th>
<th>Career category</th>
<th>‘All’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food Scientist</td>
<td>Food Technologist</td>
</tr>
<tr>
<td></td>
<td>n*</td>
<td>n*</td>
</tr>
<tr>
<td>Not applicable</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Dairy (milk, milk products, cheese, yoghurt, etc.).</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Cereals grains and baked goods</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Snack products</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Alcoholic and other beverages, excluding dairy.</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Fruit and vegetable – fresh and/or processed.</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Meat – fresh and/or processed</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Poultry – fresh and/or processed</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Fish and seafood – fresh and/or processed.</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Fats and oils including products such as margarine.</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Sugar and confectionery including chocolate.</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Ingredients manufacturing, sales and/or supply.</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Other (refer to Annexure 10)</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>

* Participants could select more than one option.

Table 2: Participants’ employment sector experience (minimum of one year)

<table>
<thead>
<tr>
<th>Employment experience (minimum of one year)</th>
<th>Career category</th>
<th>‘All’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food Scientist</td>
<td>Food Technologist</td>
</tr>
<tr>
<td></td>
<td>n*</td>
<td>n*</td>
</tr>
<tr>
<td>Not applicable</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Government</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Agriculture and primary processing.</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Food, beverage and/or related industries.</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Technical sales to food, beverage and/or related industries.</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Applied research and development.</td>
<td>42</td>
<td>27</td>
</tr>
<tr>
<td>Academia and/or pure research.</td>
<td>31</td>
<td>2</td>
</tr>
<tr>
<td>Retail sector</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Packaging sector</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Food safety and quality.</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>Food regulatory and scientific matters other than government.</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>• Marketing</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>• Chemical laboratory</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>• Deals with different sectors</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>• Fieldworker</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>• Hotel/restaurant sector</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>• Innovation/portfolio manager</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>• NGO</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>• Process improvements</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>• Procurement for the mining sector</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>• Sensory science</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

* Participants could give more than one response.
### ANNEXURE J: Survey participants additional food sector work experience

Additional food sectors/areas work experience (minimum of one year)

<table>
<thead>
<tr>
<th>Additional sectors, area/s or categories of food-related employment experience.</th>
<th>Career category</th>
<th>'Other'</th>
<th>All'</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food Scientist</td>
<td>Food Technologist</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n*</td>
<td>n*</td>
<td>n*</td>
</tr>
<tr>
<td>All/many food &amp; non-food, canning &amp; fresh produce, consultation,</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Catering</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Coffee</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Dry blending food ingredients/food products/seasoning</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Flavours &amp; oleoresins–production, sales and marketing</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Food safety systems - general</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Health products extracts of SA plants/oleoresin extraction</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>NGO – not specified</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nutraceuticals</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pet food</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Read-to-eat (RTE) meals</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Regulatory – all categories</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Soups and sauces</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Tea</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Teaching &amp; training – not specified</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Participants could select more than one option.*
ANNEXURE K: Differentiating between a food scientist and a food technologist

Table 1: Summary of analysis to responses differentiating between food scientists from food technologists: ‘Food Science’ participants

<table>
<thead>
<tr>
<th>Thematic code</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Academic focus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>5</td>
<td>11,1</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application/ applied skills /</td>
<td></td>
<td></td>
</tr>
<tr>
<td>implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>4</td>
<td>8,9</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic graduate attributes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>8</td>
<td>17,8</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial/strategic role</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>3</td>
<td>6,7</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical/hands-on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>17</td>
<td>37,0</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualification type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic</td>
<td>3</td>
<td>6,7</td>
</tr>
<tr>
<td>Vocational/work integrated learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research/Research &amp; Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>9</td>
<td>20,0</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science/scientific knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>13</td>
<td>28,9</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>4</td>
<td>8,7</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-ready</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>2</td>
<td>4,3</td>
</tr>
<tr>
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<tr>
<td>Total</td>
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</table>
Table 2: Summary of analysis to responses differentiating between food scientists from food technologists: ‘Food Technologist’ participants

<table>
<thead>
<tr>
<th>Thematic code</th>
<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td><strong>Academic focus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>2</td>
<td>5,0</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Application/ applied skills / implementation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>5</td>
<td>12,5</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Generic graduate attributes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Managerial/strategic role</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Practical/hands-on</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>25</td>
<td>62,5</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td><strong>Qualification type</strong></td>
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<td></td>
</tr>
<tr>
<td>Academic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocational/work integrated learning</td>
<td>1</td>
<td>2,5</td>
</tr>
<tr>
<td><strong>Research/Research &amp; Development</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>13</td>
<td>32,5</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Science/scientific knowledge</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>20</td>
<td>50,0</td>
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<tr>
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</tr>
<tr>
<td><strong>Technical ability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Work-ready</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td><strong>Total</strong></td>
<td>40</td>
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</table>
Table 3: Summary of analysis to responses differentiating between food scientists from food technologists: ‘Other’ participants

<table>
<thead>
<tr>
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<th>Food Scientists</th>
<th>Food Technologists</th>
</tr>
</thead>
<tbody>
<tr>
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<td>%</td>
</tr>
<tr>
<td>Academic focus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application/ applied skills/implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic graduate attributes</td>
<td></td>
<td></td>
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<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial/strategic role</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical/hands-on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
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<td></td>
</tr>
<tr>
<td>Qualification type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic</td>
<td>2</td>
<td>25,0</td>
</tr>
<tr>
<td>Vocational/work integrated learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research/Research &amp; Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science/scientific knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
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</tr>
<tr>
<td>Technical ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-ready</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less</td>
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</tr>
<tr>
<td>Total</td>
<td>8</td>
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</tbody>
</table>
# ANNEXURE L: Perceived needed personal attributes of food science and technology graduates

## Personal attributes: Groupings indicating areas of possible overlap (as a % ‘high importance’ responses of ‘All’ participants)

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Personal attributes survey questions.</th>
<th>%</th>
<th>%</th>
<th>Possible overlaps of questionnaire statements</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal qualities, dispositions and values</strong> (including personality traits such as ambition, motivation)</td>
<td>Pay attention to detail and like to do things properly.</td>
<td>97,2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accountable and responsible including the ability to admit to mistakes and accept and carry out instructions in a constructive manner.</td>
<td>95,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professionalism including presenting a positive personal image.</td>
<td>92,7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-motivated and demonstrate initiative.</td>
<td>92,7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Common-sense and logical approach to society and the workplace including the ability to analyse/solve problems and reflect on and evaluate situations and own performance.</td>
<td>92,7</td>
<td>91,9</td>
<td>Critical thinking to deconstruct a problem or situation and develop solutions to solve the problem.</td>
<td>Leadership &amp; management skills (Table 4.8)</td>
</tr>
<tr>
<td></td>
<td>Intellectual curiosity, eagerness to learning and commit to ongoing learning to meet the needs of employment and life including the ability to identify opportunities for life-long learning and learn new skills as required by the workplace.</td>
<td>91,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Positive attitude and belief that capabilities e.g. intelligence and attitudes can be continually developed.</td>
<td>90,4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Perseverance, resilience and adaptable to changing situations.</td>
<td>90,4</td>
<td>84,2</td>
<td>Adaptability and flexibility to respond to changing circumstances and new challenges</td>
<td>Leadership &amp; management skills (Table 4.8)</td>
</tr>
<tr>
<td></td>
<td>Display high energy with a ‘can do’ approach, take on tasks, set goals and continually enhance work performance level.</td>
<td>89,3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grouping</td>
<td>Personal attributes survey questions.</td>
<td>%</td>
<td>%</td>
<td>Possible overlaps of questionnaire statements</td>
<td>Section</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>Ethical sensitivity and integrity</strong></td>
<td>including trustworthiness and behaving honestly and fairly, making positive use of rules and/or values and exhibiting good work ethics.</td>
<td>84,7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Confidence</strong> in dealing with challenges in an assertive, firm and positive manner.</td>
<td></td>
<td>83,1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Creativity and the ability to be original, inventive and to apply lateral thinking.</strong></td>
<td></td>
<td>80,6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The resolve to take risks, accept challenges and speak up in difficult situations.</td>
<td></td>
<td>78,0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Take action and/or informed risks</strong> without prompting when dealing with challenges.</td>
<td></td>
<td>76,3</td>
<td>62,5</td>
<td>Leadership and/or potential leadership qualities within a variety of activities and situations.</td>
<td>Leadership &amp; management skills (Table 4.8)</td>
</tr>
<tr>
<td><strong>Ambition</strong> to better own circumstances.</td>
<td></td>
<td>72,2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Be humble and grounded.</strong></td>
<td></td>
<td>63,0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Likeability</strong> including a warm, friendly and cooperative manner</td>
<td></td>
<td>49,4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-management and organisational skills</strong></td>
<td>Self-management and the ability to multi-task.</td>
<td>92,6</td>
<td></td>
<td></td>
<td>Leadership &amp; management skills (Table 4.6)</td>
</tr>
<tr>
<td><strong>Manage stress</strong> through demonstrating the ability to retain effectiveness under pressure.</td>
<td></td>
<td>87,6</td>
<td>88,1</td>
<td>Managing work pressures effectively</td>
<td>Leadership &amp; management skills (Table 4.6)</td>
</tr>
<tr>
<td><strong>Work independently</strong> with little supervision</td>
<td></td>
<td>83,3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accept criticism</strong> without retaliating negatively.</td>
<td></td>
<td>84,7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grouping</td>
<td>Personal attributes survey questions.</td>
<td>%</td>
<td>%</td>
<td>Possible overlaps of questionnaire statements</td>
<td>Section</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>------</td>
<td>------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td><strong>Emotional intelligence, self- and social awareness and relationship management.</strong></td>
<td><strong>Self-aware</strong> of own strengths, weaknesses, aims and values.</td>
<td>80,8</td>
<td></td>
<td><strong>Interact constructively with people</strong> having different ethnic, social and educational backgrounds.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Show sensitivity, respect and empathy</strong> towards the feelings and positions of others.</td>
<td>69,3</td>
<td>68,6</td>
<td><strong>Considerate</strong> of the concerns and positions of different ethnic, social and gender groups and people with disabilities.</td>
<td>Diversity management skills (Figure 4.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Understand cultural and gender differences</strong> and take them into consideration when managing situations in the workplace.</td>
<td></td>
</tr>
<tr>
<td><strong>Global, commercial &amp; occupational awareness</strong></td>
<td><strong>Occupational awareness</strong> including nurturing the company culture and enthusiasm for food science and technology.</td>
<td>73,4</td>
<td></td>
<td><strong>Commercial awareness</strong> understanding and integrating business purposes, issues and priorities including the meaning of work, productivity and productivity improvement and quality management.</td>
<td>Leadership &amp; management skills (Table 4.8)</td>
</tr>
<tr>
<td></td>
<td><strong>Global awareness</strong> in terms of general knowledge.</td>
<td>56,0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not all participants completed this question
ANNEXURE M: South African food science and technology departments offering undergraduate qualifications

South African food science and technology departments offering food science and technology undergraduate qualifications

<table>
<thead>
<tr>
<th>Institution</th>
<th>Department</th>
<th>Undergraduate qualification/s</th>
<th>Length</th>
<th>Old NATED level</th>
<th>New HEQSF Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BScAgric: <em>Food Science</em> &amp; Agronomy or Animal Science</td>
<td>4</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Univ. of Pretoria (UP)</td>
<td>Dept. of Consumer &amp; Food Science <a href="https://www.up.ac.za/yearbooks/2017/programmes/view/02133406">https://www.up.ac.za/yearbooks/2017/programmes/view/02133406</a></td>
<td>BSc <em>Food Science</em></td>
<td>3</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Univ. of Stellenbosch (SUN)</td>
<td>Dept. of Food Science <a href="http://www.sun.ac.za/english/faculty/agri/food-science/programmes/undergraduate-programmes">http://www.sun.ac.za/english/faculty/agri/food-science/programmes/undergraduate-programmes</a></td>
<td>BSc <em>Food Science</em> (4 year)</td>
<td>4</td>
<td>7</td>
<td>8</td>
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<tr>
<td>Cape Peninsula Univ. of Technology (CPUT)</td>
<td>Dept. of Food Technology <a href="http://www.cput.ac.za/academic/faculties/appliedsciences/departments/food">http://www.cput.ac.za/academic/faculties/appliedsciences/departments/food</a></td>
<td>ND <em>Food Technology</em></td>
<td>3*</td>
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<td></td>
<td>B. Tech. <strong>Food Technology</strong></td>
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<td>1</td>
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<tr>
<td>Durban Univ. of Technology (DUT)</td>
<td>Dept. of Biotechnology &amp; Food Technology <a href="http://www.dut.ac.za/faculty/applied_sciences/biotechnology_and_food_technology/">http://www.dut.ac.za/faculty/applied_sciences/biotechnology_and_food_technology/</a></td>
<td>ND <em>Food Technology</em></td>
<td>3*</td>
<td>6</td>
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<tr>
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<td></td>
<td>B. Tech. <strong>Food Technology</strong></td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Tech. <strong>Food Technology</strong></td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

(Correct as of the 20 February 2019)
*First undergraduate programmes may be offered in an extended four-year format to facilitate wider access.

ANNEXURE N: Language editing certificate

Between the lines editing

Leatitia Romero
Professional Copy-Editor, Translator and Proofreader (BA HONS)

Cell: 083 236 4536
leatitiaromero@gmail.com
www.betweenthelinesediting.co.za

17 May 2019

To whom it may concern:

I hereby confirm that I have edited the thesis of DENISE JEAN ANN METCALFE, entitled: “EDUCATIONAL STRATEGIES TO FACILITATE GRADUATE ATTRIBUTES OF FOOD SCIENCE AND TECHNOLOGY STUDENTS”. Any amendments introduced by the author or supervisor hereafter, is not covered by this confirmation. The author ultimately decided whether to accept or decline any recommendations made by the editor, and it remains the author’s responsibility at all times to confirm the accuracy and originality of the completed work.

Leatitia Romero
(Electronically sent – no signature)

UNIVERSITY OF JOHANNESBURG

Affiliations
PEG: Professional Editors Group (ROM001)
EASA: English Academy of South Africa
SATI: South African Translators’ Institute (1003002)
SEIP: Society for Editors and Proofreaders (19587)
REASA: Research Ethics Committee Association of Southern Africa (104)