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A critical examination of food technology, innovation and teacher education: a technacy genre theory perspective

Angela Frances Turner

Southern Cross University

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A Critical Examination of Food Technology, Innovation and Teacher Education: A Technacy Genre Theory Perspective

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THESIS

Submitted for the degree of Doctor of Philosophy

Southern Cross University
Coffs Harbour, NSW, Australia

12 December 2012
A Critical Examination of Food Technology, Innovation and Teacher Education: A Technacy Genre Theory Perspective

I certify that the work presented in this thesis is, to the best of my knowledge and belief, original, except as acknowledged in the text, and that the material has not been submitted, either in whole or in part, for a degree at this or any other university.

I acknowledge that I have read and understood the University's rules, requirements, procedures and policy relating to my higher degree research award and to my thesis. I certify that I have complied with the rules, requirements, procedures and policy of the University (as they may be from time to time).

Print Name: Angela Frances Turner

Signature: [Signature]

Date: 12 December 2012
ABSTRACT

There are many and varied forces that shape food technology curriculum, but two that emerge as significant and of specific interest to this research are the perceptions of food technology education and economic trends that influence food technology. The broad goal was to examine the extent to which food technology in secondary schooling is well placed to meet emerging policy and economic demand for food innovation expertise in the industry. With both the school sector and the professional sector each asserting that their respective perceptions of Food Technology was correct, a method for clarifying and classifying the nature of the disjuncture between the two claims has been illusive. This thesis asserts that at the heart of the problem was the lack of a theoretically valid and reliable framework that may help both sectors clarify and articulate exactly what form of technology capability they are pursuing that best defines their practice and direction of scholarship.

The study was guided by the recent proposition of Technacy Genre Theory as it was assessed as offering the most contemporary and coherent approach in the literature for examining forms of technological knowledge. Technacy Genre Theory has been steadily maturing as a framework for identifying essential inter-relationships and differences between forms or genres of technological knowledge. Prior to this study, however, a method for undertaking an empirical examination of Technacy Genre Theory had not been devised or tested. A significant outcome of this research was that the critical propositions underpinning Technacy Genre Theory were both observed and able to be validated through empirical means. A method for gathering and analysing Technacy Genre data was able to support the existence of different types of technology genre identified through measuring the relationship between Human, Tool and Material ingredients (also known as the ecological elements) of technological practice. It was found that the dominant genre of technology practiced as ‘Food
Technology’ in many secondary schools was substantially and significantly different to the genre practiced by the vast majority of professional food technologists.

While the research restricted its investigation to the context of food technology, the application of Technacy Genre Theory is asserted to be transferrable to any research seeking to identify, clarify and develop various forms of technological practice. Further research is put forward in the refinement and application of Technacy Genre Theory with particular focus on how it may enhance the quality and rigor of technological knowledge across educational and technical professions. The research presented in this thesis allows for sustainable and effective learning of technological practice and innovation, and opens up the possibility of developing innovative new models of technological learning and assessment strategies across school curriculum as well as within an array of professional fields concerned with the choice and use of technologies.
ACKNOWLEDGEMENTS

An individual’s thesis is an all-encompassing activity set in a particular context and with a specific purpose in mind. It involves human agency, tool applications and data driven information, and it is rarely a silo activity. I would like to thank the following stakeholders who played an instrumental role in this research:

- The teachers involved in the early scoping stage who provided valuable discussion and information to draw on;
- The participating State Department of Education and Training curriculum officers who provided valuable insight into the historical backdrop of Technology Education and Food Technology curriculum specifically;
- Southern Cross University for granting Special Study Leave that provided the necessary release time to focus on this research;
- The School of Tourism Hospitality and Management for funding assistance, ongoing and valued support, and a positive collegial culture;
- Mel Malloch, Michael Black and Peter Bush, from the Australian Institute of Food Science and Technology Incorporated and the Food Technology Association of Australia – thank you for your ongoing support and interest in this research;
- Co-supervisor Dr Johan Edelheim – your attention to detail in feedback and expertise in food and education was a crucial contribution that ensured the thesis remained on target for submission;
- New Principal Supervisor, Professor Betty Weiler – your valued expertise in guiding me through the post examination process was greatly appreciated. Thank you.
Words cannot sufficiently express the gratitude I feel towards my original Principal Supervisor, Associate Professor Kurt Seemann. The amount of dedication and time that you have given me over the years has been truly exceptional. I thank you for countless conversations, co-authoring of papers and book chapters, reviewing numerous drafts, and above all, a valued friendship that provided endless encouragement with humour. You are an inspirational scholar and I am grateful to you for inviting me into your network of colleagues, sharing your passion and vision for technology education and guiding me on my own path towards the truth.

I am very blessed to have a wonderful partner in my life who has always supported my career aspirations and latter shift into academia. Les, and our three fabulous offspring, Brook, Kelly and Lindsay; you have all provided emotional and domestic support throughout a lengthy project that involved eating, breathing, thinking, sleeping and talking ‘thesis’. I cannot thank you all enough for being very patient and accepting when I was not the best person to live with at times, particularly during the final months. Thank you for being my best and worst critics in an attempt to keep me grounded. I would also like to thank my parents, Shirley and Frederick, who unintentionally blessed me with my artistic and essayist talents, determination and steadfastness.
This thesis is dedicated to associate co-supervisor, Associate Professor Hannah Williams, who passed away in June 2012. We shared the same vision and thinking for what ought constitute an education in Food Technology in secondary schooling. It was a great privilege to know you, and your advocacy and passion for food technology and science education will live on through this body of work.
PUBLICATIONS ARISING FROM THIS RESEARCH

This thesis evolved through published conference papers, journal articles and edited book chapters. In addition, a report for the Australian Institute Food Science and Technology Incorporated and the Department of Education and Training was produced as part of the findings from this research.


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## SHORTENED FORMS

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<th>Full Form</th>
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<tbody>
<tr>
<td>AAAS</td>
<td>American Association for the Advancement of Science</td>
</tr>
<tr>
<td>ABF</td>
<td>Australian Business Foundation</td>
</tr>
<tr>
<td>ACARA</td>
<td>Australian Curriculum Assessment Reporting Authority</td>
</tr>
<tr>
<td>AIAA</td>
<td>American Industrial Arts Association</td>
</tr>
<tr>
<td>AIFST</td>
<td>Australian Institute Food Science Technology</td>
</tr>
<tr>
<td>APU</td>
<td>Assessment of Performance Unit</td>
</tr>
<tr>
<td>ASISTM</td>
<td>Australian School Innovation in Science Technology and Mathematics project</td>
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<td>ASTEC</td>
<td>Australian Science, Technology and Engineering Council</td>
</tr>
<tr>
<td>ATSE</td>
<td>Australian Academy of Technological Sciences and Engineering</td>
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<tr>
<td>ATWORK</td>
<td>Aboriginal Technical Worker</td>
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<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
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<tr>
<td>CAM</td>
<td>Computer Aided Manufacturing</td>
</tr>
<tr>
<td>CDT</td>
<td>Craft Design and Technology</td>
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<tr>
<td>CEC</td>
<td>Content Endorsed Course</td>
</tr>
<tr>
<td>COAG</td>
<td>Council of Australian Governments</td>
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<tr>
<td>CRC</td>
<td>Co-operative Research Centre</td>
</tr>
<tr>
<td>CSIRAC</td>
<td>Commonwealth Scientific and Industrial Research Organisation Automatic Computer</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DET</td>
<td>Department Education and Training</td>
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<tr>
<td>DfES</td>
<td>Department for Education and Skills</td>
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<tr>
<td>EE</td>
<td>Expectations and experiences</td>
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<td>FASC</td>
<td>Food as a scholarly choice</td>
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<td>FAOS</td>
<td>Food as an area of study</td>
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<td>FST</td>
<td>Food Science and Technology</td>
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<tr>
<td>HASS</td>
<td>Humanities and Social Sciences</td>
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<tr>
<td>HSC</td>
<td>Higher School Certificate</td>
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<td>HREC</td>
<td>Human Research Ethics Committee</td>
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<td>IT</td>
<td>Instructional Technology</td>
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<td>ICT</td>
<td>Information and Communications Technology</td>
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<td>ITEA</td>
<td>International Technology Education Association</td>
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<td>K&amp;T</td>
<td>Knowledge and techniques</td>
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<td>MCEECDYA</td>
<td>Ministerial Council for Education, Early Childhood Development and Youth Affairs</td>
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<tr>
<td>M&amp;I</td>
<td>Materials and Ingredients</td>
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<tr>
<td>NAE</td>
<td>National Academy of Engineering</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<tr>
<td>NEA</td>
<td>National Educational Association</td>
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<tr>
<td>NRC</td>
<td>National Research Council</td>
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<tr>
<td>NSF</td>
<td>National Science Foundation</td>
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<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OH&amp;S</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>PASW</td>
<td>Predictive Analysis Software Statistics</td>
</tr>
<tr>
<td>PMSEIC</td>
<td>Prime Minister’s Science, Engineering and Innovation Council</td>
</tr>
<tr>
<td>QCA</td>
<td>Qualifications Curriculum Authority</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<tr>
<td>SERAP</td>
<td>State Education Research Approval Process</td>
</tr>
<tr>
<td>STEM</td>
<td>Science Technology Engineering and Mathematics</td>
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<tr>
<td>TAS</td>
<td>Technological and Applied Studies</td>
</tr>
<tr>
<td>T&amp;E</td>
<td>Tools and equipment</td>
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</table>
TFA  Technical Foundation of America
TVEI  Technical and Vocational Education Initiative
UAC  Universities Admission Centre
UK  United Kingdom
UNESCO  United Nations Educational Scientific and Cultural Organisation
USA  United States of America
VET  Vocational Education and Training
VOCED  Vocational Education
GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Ecological overshoot</td>
<td>when humanity has exhausted nature’s resources</td>
</tr>
<tr>
<td>Food Science</td>
<td>The study of the physical, biological, and chemical makeup of food and the concepts underlying food processing.</td>
</tr>
<tr>
<td>Food Technology</td>
<td>Food technology is the application of food science to the selection, preservation, processing, packaging, distribution and use of safe food.</td>
</tr>
<tr>
<td>Food Technology studies</td>
<td>Food Technology belongs to the general field of technological studies, which is often presented variously in Australian primary and secondary schools as part of or at least associated with, the Design and Technology curriculum.</td>
</tr>
<tr>
<td>Innovation</td>
<td>Introducing new ideas, products or methods that bring value to an intended audience</td>
</tr>
<tr>
<td>Poiesis</td>
<td>A word element meaning <code>making', </code>creation', `genesis', as in erythropoiesis. [Greek poiēsis act of making]. Artisan practical skills using calculative and expressive thought.</td>
</tr>
<tr>
<td>Praxis</td>
<td>1. Practice, especially as opposed to theory 2. Habit; custom 3. A set of examples for practice. [Medieval Latin, from Greek]</td>
</tr>
<tr>
<td>Scoping study</td>
<td>The early stage of a project where preliminary assessment of the potential size and scope of research literature is identified.</td>
</tr>
<tr>
<td>Technacy</td>
<td>An Australian expression that refers to an holistic understanding of technology; especially how the interrelationship between people, tools systems and the material environment are combined through processes of design to meet a purpose and a context of use.</td>
</tr>
<tr>
<td>Techne</td>
<td>The principles or methods employed in making something; [Greek, techné “art, craft, or skill”]</td>
</tr>
<tr>
<td>Technate</td>
<td>The ability for people to think and work creatively in all genres of technology</td>
</tr>
<tr>
<td>Technical</td>
<td>1. Relating to an art, science, or technical skill. 2. Peculiar to or characteristic of a particular art, science, and profession, trade: technical details. 3. Skilled in, or familiar in a practical way with, a particular art, trade, etc., as a person. 5. Relating to or connected with the mechanical or industrial arts and the applied sciences: a technical school.</td>
</tr>
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CHAPTER 1: INTRODUCTION

1.1 SCOPE OF STUDY

Technology is seen in limited terms: if it is not computers then it is vocational technical training, and rarely ever is the whole spectrum of technology that constitutes its existence between these bookends made apparent, explored or debated. In the curriculum of many nations technology is portrayed as a process or thing one is simply taught to use, rather than study. It is at best the metaphor for building the skills of a labour force to given standards, and at worst it is the school subject that offers students mental recess before carrying on in the more noble studies of subjects associated with literacy and numeracy such as language, mathematics or science (Seemann, 2009, p.117).

Nutrition, healthy lifestyle and nutrition related adolescent food issues are the most obvious aspects of food content included in the curriculum. Many educators consider food preparation and safe handling essential life skills. Stakeholders report that students generally respond favourably to this aspect of the subject and utilise the experiences as a useful background to part-time employment and perhaps a later career. Students generally do not view food production and food processing in the same light and generally equate food technology with the hospitality industry (KPA, 2003, p. 40).

This thesis examines what we mean when we say ‘Food Technology’ and its practical manifestation. The study aimed to clarify the confusion between two groups using the same label, each claiming their version as correct for Food Technology. The study also aimed to establish the best way to identify the forms of technology practice to facilitate Food Technology education. While dictionary definitions may appear to be the obvious source for resolving the meaning of Food Technology, in practice the task is far more complex given the considerable systemic investments different stakeholders have made in the field of food technology studies. Equally, given the increasing diversity of innovative technologies that school students, teachers and professionals must now navigate, evaluate and sustainably exploit in their lives, the need to develop a means to clarify and classify all forms of technology knowledge and practice emerges as significant. It is asserted that
access to a validated means for learners, teachers and professionals to identify the common form of technology knowledge and practice, both historically and as they emerge, offers improved frameworks not only for the teaching and learning pathways from schools into Food Technology studies, but potentially into all forms of technology knowledge and practice. This thesis proposes that Technacy Genre theory underpins conceptual and praxeological understanding of technology as a universal framework for all its forms and can be empirically tested. To this end, this thesis also examined how the differences in technology knowledge and practice may affect the ‘supply’ pathway from school to the ‘demand’ entry into professional Food Technology careers and higher education. In this context, the professional food technologists were identified as the reference group while the food technology and secondary teachers were identified as the comparative group. The study therefore sought to critique food technology in schooling and how well their form of practice aligned with that of the professional food technologists.

and Zuga, 1997, 1999, 2004). Additionally, the dearth of literature in Food Technology education as a branch of study under design and technology education is particularly significant 1.

While some scholars have highlighted the need for a new nutrition science that partners food engineering science in shaping food-environment interactions (Carlsson-Kanyama & González, 2009; Duchin, 2005; Eshel & Martin, 2009; Wahlqvist, 2005), others assert that in this complex ecological landscape a scientific relationship should be in proportion with critical problem solving and designing skills as best practice for exploring the ecological fundamentals of food technology studies (Barlex & Rutland, 2003; Farrell, 2003; Jideani & Jideani, 2010; Rutland, 2005, 2008, 2008a, 2009; Rutland & Barlex, 2009; Weaver-Hightower, 2011). Even as the threat to ecosystems and food security from climate-change and the current trend where bio-fuels are competing for the same prime land required for food production, a conservative culture of food school teachers is marginalising food innovation capacity building in our students (Australian Bureau Agricultural and Resource Economics, 2008; Australian Food & Grocery Council, 2010; Australian Government AusAID, 2010; Bauman, 1998; Carberry, 2010; Cribb, 2010; Crimp & Howden, 2010; CSIRO and Bureau of Meteorology, 2007; Food and Agriculture Organization of the

1 Database cross search* was conducted combining key terms noted below through EBSCO-Eric and Education Research Complete; SpringerLink; ProQuest General and Dissertations and Theses; SAGE Premier; ISI-Web of Knowledge General and Science; International Information System for the Agricultural Sciences and Technology (AGRIS) repository; JSTOR and ScienceDirect. Specific journals were also accessed: British Food Journal; The Journal of Technology Education; the International Journal of Technology and Design Education and Design and Technology Education: An International Journal. 5 literature works of relevance pertaining to teacher perceptions of food science and technology and technology education were located. 22 literature works of broad relevance to education included ecological literacy for food; the status of food in design and technology education; cooking as a scientific experiment; food and higher education for sustainable development; food, land, natural resources and environmental aspects in general that broadly connected with education. Other literature emphasised the need for science teachers to practice more food science and food science for early childhood and primary were identified rather than secondary food education. While these were useful in part, many failed to specifically address the structure of the study or make transparent the link between ecology and food technology and the association between the food science and technology industry. The remaining literature that was not relevant to this thesis focused on food hygiene, nutrition, cultural aspects, food service; special needs students; cooking and consumption; food safety; allergies. The results from the extensive search strongly suggest there is minimal to almost non-existent dedicated research available in the field of Food Technology education as it pertains to current trends and complexities to meet food security, sustainability and innovation capacity building. * “cross search” means searching across general, education and science database fields rather than in one specific field like ‘author’, ‘title’ or ‘description’; * and “?” were used to search for all and any word that started with the string preceding the * or “?” character: thus phrasing such as “teacher perceptions food technolog?”; “food technology education?”; “food technolog?”; “food education?”; “food stud?” located documents where the whole phrase was present or located singular words in the phrasing and accommodated spelling/singular or plural variances. For those data bases that did not accept two or more words entered into the search box as a phrase, quotation marks were used only. Word truncation was also employed: thus teacher perceptions food technolog*; food technology education*; food technolog*; food education*; food stud* located documents containing “teachers”, “perception”, “foods”, “educational”, “technologies”, “study”.
United Nations, 2008; Lillford, 2010; Martin, 2007; Meadows, Meadows, & Randers, 1972, 2004; Stern, 2007; Wahlqvist, 2005; Working Group Intergovenmental Panel Climate Change, 2007). Whilst there is a place for internal matters, such as life skills cooking and consumption in the learning of domestic food purposes, the socialisation of people who are inclined to be innovative about food as a sustainable scientific enterprise appears to remain peripheral in secondary Food Technology education (Liedtke, Welfens, Schaefer, & Baedeker, 2008; Nemeskeri & Mont, 2008; Schafer & Bamberg, 2008).

This thesis makes an original and significant contribution to the literature of Design and Technology Education research, with specific reference to the task of extending the understanding of the complex nature of food technology knowledge and practice. While the research uses Food Technology education as an example of a contested field of knowledge, the ideas and methods presented in the thesis are argued to be transferrable to other forms of contested technology knowledge and practice. Throughout this thesis, the assertion of contested understanding is contained to the perceptions of secondary teaching and school curriculum relative to the wider domain of Food Technologists in higher education and professional affiliations to the food science and technology industries and associations – food science and food technology are used interchangeably throughout the thesis as Food technology is the application of food science to the selection, preservation, processing, packaging, distribution and use of safe food. To guide this study, a theoretical framework was designed from a technological perspective that draws on principles of innovation as an integrative and overlapping theme. Specific attention is drawn to the holistic dimension of themes as articulated through Technacy Theory, referred to hereafter as Technacy Genre Theory (forms of technology practice).

This research provided a snapshot of the nexus between the perceptions of food technologists and those of secondary food technology teachers with regard to academic
culture and knowledge, technical systems and equipment used, and relevant material ingredients involved in food technology practice. The scope of this study includes examining the role secondary education may play in ‘supplying’ people into professional studies towards a career as a food technologist. In this arrangement, the industry and profession of Food Technology represent the ‘demand’, or ‘inside view’, of the field of knowledge. This starts with receiving students into undergraduate food science and technology courses that are ‘supplied’ by the school sector or the ‘outside view’ of the field of knowledge (i.e. schools do not collaborate with the professionals in the subjects they teach and that this is the basis to the contested understanding of the subject).

This thesis contributes to improving a conceptual framework in technology judgement for the study of Food Technology and one that is relevant to both the future of schooling in the technology area and to the development of the food profession outside of school. Relative attention to goals concerning sustainability, economic trends and innovation capacity building were measured as these areas remain topical in the wider context of the field of food technology research and emerging world concerns for innovative and sustainable means of food development, production and affordability (Australian Conservation Foundation, 2008; Australian Government, 2010; Australian Government Department Education Science Training, 2003; Barbier, 2009; Commonwealth of Australia Department of Innovation Industry Science and Research, 2009; Commonwealth of Australia Department of the Environment Water Heritage and the Arts, 2010; Commonwealth Science and Industry Research Organisation, 2010; Cutler & Company, 2008; Department of Employment and Workplace Relations, 2005; Gardner, 2007; Garnett, 2011; Godin, 2010; Innovation Summit Implementation Group, 2000; Kennedy, 2007; Larson, Ryan, & Abraham, 2008; Lonescu-Somers & Steger, 2008; Meadows, Meadows, & Randers, 1972; Meadows, et al., 2004; O'Sullivan & Dooley, 2009; Organisation for Economic Co-

1.1.1 Curriculum Evolution and the Rapid Change of Food Innovation

The pace and development of the field of technology has accelerated exponentially with many degrees of complexity and sophistication (Australian Government Department Education Science Training, 2003; Carayannis, Popescu, Sipp & Stewart, 2006; Kurzweil, 1999, 2001). However, the school sector for many reasons has been struggling to keep pace with not only new technological developments, but more importantly, new understandings underpinning general technological knowledge and practice (Elshof, 2005, 2008, 2009; Ferrari, 2007; Gagel, 2006; Goodyer, 1999; Jideani & Jideani, 2010; Johnson, 2008; Keirl, 2004; Lawson, 2000; Seemann, 2004, 2004a, 2007; Slaughter, 1999, 2000; Strange & Bayley, 2008; Whitby, 2007).

While technological education in schools and teacher development programs struggle to align generally with the nature and currency of technology knowledge outside the school system, the wider profession of food technology is a specific area that has advanced enormously in knowledge, accelerating in its own science. This scenario raises the need to examine how food technology is tracking in schools relative to the wider advancements in that field and to assess the degree of lag and its effect on society and the school community’s understanding of the subject on completion of the formative years of compulsory education.

Food innovation has been identified as a key area for the provision of food security and world hunger, yet the growing food demand has created an imbalanced picture between the
world’s food production systems, population growth and global food security for
developing and developed countries (Australian Government AusAID, 2010; Carberry,
2010; Food and Agriculture Organisation of the United Nations, 2010a; New South Wales
Government, 2009; Royal Society of Chemistry, 2010). The burgeoning consumer
appetites of developed countries for synthesised new food products, particularly for the
back entry of food outlets and many institutions such as schools, further raise the demands
for unlimited and cheap food production and supply (Australian Government AusAID,
2010; Bridgestock, 2011; Carberry, 2010; Cribb, 2010; Crimp & Howden, 2010; Food and
Agriculture Organisation of the United Nations, 2010a; Martin, 2007; Meadows, et al.,
2004; New South Wales Government, 2009; Royal Society of Chemistry, 2010; Sellahewa,
2010; Wackernagel, Schulz, Deumling, Linares, Jenkins, Kapos, Monfreda, Loh, Myers,

global food demand for today and for the future is dependent on the earth’s carrying
capacity. This has already reached resource overshoot due to the ecological footprint from
exponential global population growth since the Industrial Revolution.

Thus, the ecological impact of humanity is measured as the area of
biologically productive land and water required to produce the
resources consumed and to assimilate the wastes generated by
humanity, under the predominant management and production practices
in any given year. Not only human demand on nature, but also nature’s
supply changes over time because of innovations in technology and
resource management, changes in land use, and cumulative damage of
past impacts (Wackernagel, et al., 2002, p. 6).
Figure 1: Ecological Footprint versus Carrying Capacity

Figure 1 Shows the number of Earths required to provide the resources used by humanity and to absorb their emissions for each year since 1960. This human demand is compared with the available supply: our one planet Earth. Human demand exceeds nature’s supply from the 1980’s onward, overshooting it by some 20 percent in 1999 (Meadows, et al., 2004, p. xv).

Figure 2: Future pressure in 50 years

Figure 2 Illustrates driving consumption and diet changes; energy demands driving land, water and biomass diversions to bio-energy and high food wastage rates (Carberry, 2010, p. 5).
In the supply chain of developing human capability in Food Technology studies and innovation, a key foundational link is the quality and accuracy of Food Technology education in schools. Given the issues presented, there is a need to coherently identify the content being taught under the label of Food Technology in schools as this has been brought into question by sectors of the wider profession of food technologists. AIFST members from the food and related industries and teaching institutions have expressed their concern that the national skills base in food science and technology in Australia is decreasing and the future of food science and technology education of graduates for the Australian food industry is threatened (Education Providers Working Group of the Australian Institute Food Science and Technology, 2008; B. Cox, Research Fellow CSIRO, personal communication, February 18, 2008; Dr. A. Lee [Program Authority for UG Food Science, NSW University], personal communication, March 25, 2009; M. Malloch [Executive Manager AIFST], personal communication, June, 10, 2008; Dr. K. Pearce [PhD Program Director for Nutrition and Food Science, University South Australia], personal communication, November 15, 2009; Dr S Richard, [Research Scientist Asian Foods, Bri Research], personal communication, July 25, 2009; Dr. H. Williams [Program Leader Food Science and Technology, Curtin University], personal communication, November 20, 2009; P. Bush [Secretary Food Technology Association of Australia], personal communication, March 30, 2010).

The study of Food Technology is central to underpinning food security and understanding the vulnerability of our ecology, but the disconnect between the school interpretation of Food Technology and the wider professional view of the same has posed considerable problems for the Australian Food Technology profession and recruitment of students’ into Food Technology degrees (Education Providers Working Group of the Australian Institute
Food Science and Technology, 2009; Jideani & Jideani, 2010; KPA, 2003; The Allen Consulting Group, 2011). Although the literature suggests a problem concerning the disconnect between schools and industry sectors, there was no guidance in the research literature for framing a method to solve the conundrum; nor a way to test for any difference concerning forms of technological knowledge. This thesis proposes a technological framework for this research in technology and teacher education as a way to clarify food technology as a subject.

1.1.2 Utility of Technology Theories

Scholars have long debated the evolving history of technology as artefact, but there has not been the same continuous tradition to evolve the philosophy of technology or to develop general theories of the nature of technology as a form of knowledge with discipline-unique principles. Western foundations of contemporary work examining the possibility of a general theory of technology may be linked to key writers such as Lewis Mumford’s 1963 “Technics and Civilisation”, Don Ihde’s 1979 “Technics and Praxis”, Marx Wartofsky’s 1979 “Models”, and influential educationists like John Dewey with his seminal work in 1938, “Experience and education”. In more recent years, a renewed interest has emerged to examine the underlying form of technology and its general characteristics by scholars, including Andrew Feenburg with his work on “The Ten Paradoxes of Technology” in 2009 and Seemann with his work on “Technacy Theory” since 1995.

The review of literature for this thesis previews selected ideas concerning the emerging body of work that articulates a general theory of technology and that offers the most relevant propositions to this research. As an interdisciplinary area of study fundamentally different to other knowledge domains (Compton, 2004), there are overlapping themes and relationships of “different kinds of technologies from a variety of epistemological
approaches; the humanities, social science, natural science, sociology, psychology, engineering sciences and different philosophical schools of thought” (Kyrre, Olsen, Pedersen, & Hendrick, 2009, p. 1). However, few propositions coherently examine a schema of technology as a discipline with underlying theorems that guide the structure of what students need to learn. Fundamental propositions about a field of knowledge is apparent in the constructs of science, which articulates the scientific method (Popper, 2002). Similarly, this thesis seeks to make a significant contribution to the literature that aims to articulate the theoretical foundations to the epistemological and ontological form of Technology.

1.1.3 Need for this study

Food Technology was selected as a curriculum clarification issue in research because sustainable and healthy world food supplies have reached serious levels of concern demanding that society develop more innovators in this area for our future to help address the challenge, yet the same subject area in school systems can often be presented in much more conservative formats (Australian Food & Grocery Council, 2010; Australian Government AusAID, 2010a; Bridgestock, 2011; Carberry, 2010; Cribb, 2010; Food and Agriculture Organisation of the United Nations, 2010a, 2010b; Royal Society of Chemistry, 2010; World Vision, 2009). This study examined to what extent Food Technology schooling can meet emerging policy and economic demand for food innovation expertise in the industry and provides knowledge about an enduring educational practice under the label of Food Technology. While a vocational end-user cooking skill and consumption approach under the label of Food Technology may be common to many schools, it is not necessarily found in all schools. The role education can play in helping
prepare society to develop a culture of innovation and sustainability around food practice is crucial and deserves clarification.

This thesis makes transparent perceptions between schools and the wider profession of food technology and in this process identified that two domains of practice are essentially referring to two separate forms of Technology Genre. Previous research is limited in this area but in particular literature that discerns between two typologies of practice under the one label is non-existent. The need to discern between two areas of practice further contributes to the field of Design and Technology education research as a measure of developing a common frame of conceptual understanding in technological activity. Additionally, this research contributes to an international community of scholars and the academy of the International Journal of Technology and Design, and the Journal of Technology Education. In the wider field of relevant scholarship this research holds significant relevance for informing the Design and Technology curriculum amidst the unfolding Australian National Curriculum framework. The broader need for this research advances from a long standing Australian government agenda since 1996 for sustainability and innovation capacity building in students (Australian Government Department Education Science Training, 2003; Australian Science Technology and Engineering Council, 1996; Commonwealth Government of Australia, 2001; Commonwealth Government of Australia, 2008; Commonwealth of Australia Department of Industry Science Resources, 1999; Commonwealth of Australia Department of Innovation Industry Science and Research, 2009; Commonwealth of Australia Department of the Environment Water Heritage and the Arts, 2010).
Population, consumption, technology, development, and the environment are linked in complex relationships that bear closely on human welfare in the global neighbourhood. Their effective and equitable management calls for a systemic, long-term, global approach guided by the principle of sustainable development (Commission of Global Governance, 1995, p. 30).

Where human-induced climate change by developed nations now prevails as an historic fact and shoulders little responsibility for lesser developed countries (International Institute for Sustainable Development, 2002; Organisation for Economic Cooperation and Development, 2007 a-a; Pearce, 2006), it makes sense that the study of Food Technology should educate our students well into the next decade and that students develop suitable attributes to embrace change; the students can then differentiate human technological practice and possess a capacity for making long term sustainable decisions. This state of play on the planet and the major tragedy that has unfolded now affects the security of water supply, food and energy (Stern, 2007) and as such now demands an environmental conscience from Food Technology students. However, sustainability is barely mentioned in food curriculum. Additionally, innovation as an area of study remains a noticeable vacuum since removal from the syllabus in 1999.

If our expectations for a utopian future are to be met we need to understand the future demands that are upon us. This thesis concerns the future demands of sustainability and innovation and food demand in that direction. Literature suggests that a multifaceted skills set is required for teaching and fostering important aspects of innovation knowledge and practice (Australian Government Department Education Science Training, 2003; Commonwealth Government of Australia, 2001; Commonwealth of Australia Department of Innovation Industry Science and Research, 2009; Innovation Summit Implementation Group, 2000; Organisation for Economic Co-Operation and Development, 2007c). In
technology education and food technology specifically, to enable a culture of innovation to grow in educational systems, a student’s innovative capacity needs to be realised. Schools and teachers need to cultivate versatility, imagination, inventiveness, reliability and resilience that may embody for them possible forms of expression through exploration and experimentation.

At all levels, our society will require creative individuals able to communicate well, think originally and critically, adapt to change, work cooperatively, remain motivated when faced with difficult circumstances, who connect with people and ideas and are capable of finding solutions to problems as they occur-in short, individuals with the array of skills constituting a well-developed capacity for innovation (Australian Government Department Education Science Training, 2003, p. 5).

Keirl (2004, p. 86) adds that if schools are to nurture a culture of innovation and creativity then traits such as “imagination, rule-breaking and shifty-thinking” would be of “serious interest to sensitive educators”. Students in tomorrow’s world will need the ability to make informed decisions about a whole range of matters quickly and effectively. This will require increasing knowledge and an understanding of science and technology, and the global environments that these occupy. It is clear that informed and capable citizens in the 21st century will need to be both literate and numerate in the purest sense of the terms and increasingly be scientifically and technologically literate (Australian Government Department Education Science Training, 2003; Australian Science Technology and Engineering Council, 1996; Walker, 2000). Cardwell (2005) adds that many forms of literacy exist and with each literacy an integration of a suite of skills, yet he ponders the narrow focus and attention given and questions whether education is on the right course. He advocates that a broader literacy is required to imply all levels of scientific literacy about food, land, natural resources and the environment are needed.
It is my view that we have failed to develop a systems perspective around which we can frame our relationships and our understandings about our physical and biological world of which all humans are a part. We have failed to build the connections and understanding of the dependence and interdependence among life systems. How we use and protect the earth’s capacity to provide for humankind through informed personal, social and political action will determine the future for all (ibid, 2005, p. 112).

Discourse concerning technology in society and related branches of study run parallel to the study of literacy and numeracy. Where literate individuals would build from a functional level of basic reading and comprehension to more sophisticated levels of poetry and advanced comprehension, numerate individuals on the other hand build from basic math and algebra to sophisticated levels of trigonometry, calculus and statistics (Australian Government, 2011). Conversely, the study of technology would develop technate individuals who would build from basic knowledge, comprehension and technical skills and application as an emergent stage of their learning, to developing more sophisticated levels, such as analysis, synthesis and evaluation through design (Seemann, 2011). Just as other disciplines in the sciences and the humanities strive to foster individuals who are literate and numerate, technology educators ought strive to foster technate individuals who are “skilled, holistic thinkers and doers who can select, evaluate, transform and use appropriate technologies that are responsive to local contexts and human needs” (Seemann, 2001, p. 2). Walker (personal communication, December, 4, 2009) emphasised that literacy skills enables you to elevate in a qualitative way while numeracy skills allow you to operate in two dimensions (although many claim one is able to operate in three dimensions, but only on paper), whereas Technacy allows one to be brought to that third dimension that draws out skills of synthesis.
Technacy provides a framework for considering science and technology within a socio-environmental context. Technacy is a way of defining the meaning of technological literacy that goes beyond competency in using technology. Technacy is the technological equivalent of literacy and numeracy, and relates to a holistic view of problem solving, communication and practice that includes consideration of social technical and environmental resources and constraints...It is this technacy which should be taught in primary school not a history of science and technology or manual crafts or computing (Walker, 2000, p. 12).

Dakers (2005) concurs that in order to prepare citizens to live in a technologically mediated world students need to “understand what technology is, how it is created, how societies shape it and how, in turn, it shapes societies” (p.77). On the other hand Wright’s (1992) earlier perception for the need to establish an ‘arena’ for technology education as a discipline remains incomplete. For example, science requires evidence based on consistent patterns identified through hypothesis testing and theories, “its arena, then, is focused on the procedures used to study the natural world and the impacts these findings have on human knowledge” (p. 63). Where literacy contains various text types to master, the ‘arena’ then focuses on narrative; transactional, procedural and persuasive texts; recounts; reports and explanations.

Seemann (2001) puts forward that technological literacy involves a three dimensional response that requires an individual to be adaptable beyond the competency of using technologies across multiple technology genres that may include, but not be restricted to for example, information communication technologies; timber, metal, electronics, food, textiles, composite and emerging technologies. The ‘arena’ would be defined in general terms as elements of human agency, tools and material/ecological aspects. In an applied setting technacy purposefully considers social, ethical, technical and environmental resources and constraints such as time, budget and resource availability common to all
technological practice. From a technological perspective, this thesis proposes technacy has been the missing link in holistic education as a valuable competency equal to literacy and numeracy.

Additionally, a technate individual possesses a suite of skills more in common with innovators and entrepreneurs rather than competency use of technology alone (Seemann, 2003, 2004, 2006a). In the context of food technology, if the subject is confused with, perpetrated as, or diminished in curriculum and teacher education to that of predominately class-room cooking skills, and at the expense of innovation and design knowledge and skills, then the collective effect on society, this thesis argues, may be undesirable and risky.

1.2 THESIS AIMS AND PROPOSAL

This thesis explored the evolution of policy and culture in the wider professional food technology industry and the evolution of curriculum and teacher culture in food technology schooling. The aim was to clarify food technology as a school subject by mapping historical and contemporary relationships as a way to identify any similarities or differences between industry and schooling knowledge, technical systems or equipment used, and relevant material ingredients involved in food technology practice. The merits of Technacy Genre Theory were investigated as a framework to measure and identify
similarities or different types of technological genre practice. This thesis proposes that Technacy Genre Theory can articulate both a core place for the study of values and practice and a place for emerging knowledge with particular regard to innovation.

The knowledge gained from this research will inform and better align educational services with the food science and technology profession and nurture a culture towards the national priority in innovation and sustainability.

- **To participants:** The expected benefits aim to improve school-based pedagogy in the teaching area of food technology that is more aligned with food technology science industry practice and emerging trends in the field.
- **To the broader community:** That society will benefit through a culture of innovation attributes among professionals in the field of food technology studies.
- **To advance the academy of Design and Technology Education:** A generic theoretical framework suitable for, not only food technology, but for all technology genre studies in that it allows for sustainable and effective understanding and learning of technology and innovation education.

### 1.2.1 Field of Study

This research is positioned in the general field of Design and Technology Education research under the Field of Research code 130299 Curriculum and Pedagogy not elsewhere classified. Although 130212 Science, Technology and Engineering Curriculum and Pedagogy would appear to be the best fit, in the school system Science and Engineering are separate areas of study to Design and Technology, while Technology constitutes using computers for the purpose of programming hardware. In addition, the Field of Research for Technology constitutes specific disciplines for sciences or computers only. For
example: Biotechnology: 1001 Agricultural 1002 Environmental; 1003 Industrial; 1004 Medical and for computers: 1005 Communications Technologies; 1006 Computer Hardware and 1007 Nanotechnology (Australian Bureau of Statistics, 2008). As there is no code identifier for Design and Technology education this, in itself, substantiates a need for a robust theory of Technology as a generic discipline of our made world.

Within Design and Technology curriculum there is a branch of study for Food Technology. This research is interested in the school view of food technology education relative to the big challenges outside the school as emerging in the wider professional study of food technology and whether or not the two are in agreement with each other on what is important to learn. Thus, of specific interest to this research is whether or not there is a difference between the school view and the outside view and how that could be empirically detected. Given the global problems that are evidenced for food security and sustainability, this research is interested in whether or not a key topical issue of sustainable futures is entrenched in the way schooling teaches food technology and what the student’s capability ought be, given there is a wider global context they will need to navigate through and act in later on (Australian Food & Grocery Council, 2010; Australian Government AusAID, 2010; Carberry, 2010; Cardwell, 2005; Commonwealth Science and Industry Research Organisation, 2010; Cribb, 2010; Food and Agriculture Organisation of the United Nations, 2010a, 2010b; Royal Society of Chemistry, 2010; World Vision, 2009). Of specific interest to this research are concerns whether or not there is a difference between the school view and the outside view and how that could be empirically detected.

1.2.2 Context of Study

This thesis asserts that the field of Technology Education, in particular Food Technology, lacks a coherent framework to make sense of what is both generic to all genres of
technology and why different genres of technology, specifically Food Technology, is enhanced when it utilises a more generic theoretical framework for technology studies. The research explores the utility of Technacy Theory (Australian Science Technology and Engineering Council, 1996; Department of Education Science and Training, 2003; Ramsey, 2004; Seemann, 2003; Seemann & Talbot, 1995) as a suitable framework for the study of Food Technology and examined emerging understanding of the human qualities to be fostered in innovation education. This proposal explores the following key dimensions of priority areas:

- Demand drivers: including federal, state and government-industry linked initiatives
- Supply drivers: including state, school, teacher education, classroom culture and curriculum
- Analysis of demand responsiveness to expressed supply: including formation of suitable frameworks and processes for fostering coherent and transferable capacities in innovation.

In particular, this research is interested in the degree to which the supply side of education is responding to the demand drivers and analysing these dynamic pathways towards more demand-responsive educational supply strategies that better align educational services and cultures towards fostering the national priority in innovation.

1.2.3 Research Ethics

Ethical responsibilities in this research were extended to those involved and rights and values were respected through voluntary participation; informed consent; no harm; confidentiality or anonymity and privacy. Potentially conflicting ethical principles,
methods or procedures also needed to be considered to ensure validity and reliability (Burns, 2000; De Vaus, 2002, 2006; McMillan & Schumacher, 2006). The study for this thesis constituted submissions through two institutions:

1) Southern Cross University Human Research Ethics Committee (HREC), in accordance with the National Statement on Ethical Conduct in Human Research

Stage 1 involved preliminary scoping activities through classroom observations and discussions with teachers, interviews with DET personnel, and phone conversations with food professionals. This process aimed to capture impressions and broad issues specific to the development of the survey instrument questions for structured data collection in Stage 2. The purpose of the study was explained to the participants verbally and through an Information Sheet. The participants agreed through signing a letter of consent. A pilot survey was then distributed to selected participants on the basis of their profile alignment to that of the participants to whom the final survey would be sent. The purpose of the study was explained to the selected participants through an Information Sheet attached to the survey instrument with a pilot survey feedback sheet supplied. Reports were sent to the Principals of the participating schools upon completion of Stage 1.

Accordingly, an updated ethics application for Stage 2 was submitted for implementation of a hard copy survey instrument to teachers, food science and technology industry professionals, undergraduate and postgraduate students. The purpose of the study was explained to the participants through an Information Sheet attached to the survey instrument and consent was implied through the return of the survey. This submission was amended to include an online survey replicating the hard copy version. Participant confidentiality outlined in the Information Letters was assured during both stages of the
study. Ethic approval for this research and the survey instrument can be located in Appendix 1.

1.2.4 Main Research Question

This study acknowledges culture and community of schooling for preparing students beyond the school gate. For technology education, courses offer a general education regardless of where a student’s career path may take them. This thesis questions whether the traditional general education approach is enough to lead our students into the 21st century.

The argument all along with all technology subjects is that it provides a broad base of knowledge and skills that are applicable to all aspects of your life … so, an important framework for learning, thinking, creativity and problem solving. Being able to develop technological skills, as a need and all those sorts of things, that are really valuable for aspects of life regardless of what job pathway you choose. We would argue quite strongly that this is not a subject that is purely about career choices, (career choice is one bonus) but in fact it is a general education subject that has great value for anybody whether they choose as a career pathway or not and we would argue that point about the technology subjects. So that is an important difference to make (pers.com Chief Curriculum Officer, NSW DET, 2007).

This study sought to find answers to three questions that lie at the heart of the research conducted in this thesis:

To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists?

a) What is the evolution of policy and industry knowledge in Food Technology?

b) How can forms of technology practice be identified in Food Technology education?

This thesis attempts to develop a response to these key questions.
1.3 DEFINITION OF TERMS

The key domain of this thesis concerns Food Technology. Literature suggests technology is multifaceted and complex and therefore difficult to define as an all-encompassing term; however it is easily defined in the context in which it is used. A key aspect of interest from the literature associates understandings with semantics and the impact differing interpretations have toward technological knowledge and practice (Fleer & Jane, 2004; Keirl, 2004, 2006; Lewis, 1991; Rapp 1981; Willoughby, 1990, 2005). This section of the thesis establishes the meaning of key terms used in the study to assure semantic continuity. Associated with the expression ‘food technology’ is the key idea of ‘Technology’ itself. ‘Technacy’ is then defined as it relates to the forms of knowledge and practice that this thesis analyses. Following an operational definition of Food Technology, the thesis also defines ‘innovation’ as this capability is “key to future growth and prosperity in a global economy” (Australian Government Department Education Science Training, 2003, p. xvii).

1.3.1 Defining Technology

Scholars remind us that the etymological origin of ‘technology’ is its derivative of the Greek word ‘tekhné’ (Dakers, 2005; Feenberg, 2006, p. 6; Willoughby, 1990, p. 28). ‘Techné’ describes practical knowledge and skill as a unified process of the arts and crafts, while ‘logos’ was associated with the ideas, reason or principle of the art or craft. In more contemporary terms the United Nations Educational, Scientific and Cultural Organisation (UNESCO) described technology in a very broad sense:

Technology is the know-how and creative process that may utilise tools, resources and systems to solve problems to enhance control over the natural and man-made environment with an endeavour to improve the human condition (UNESCO, 1985, p. 3).
Australian educational institutions in NSW expanded their own meaning around this term:

Technology is the purposeful application of knowledge, experience and resources to create products and processes that meet human needs (Curriculum Corporation, 1994a, p. 3);

Students recognise problems and respond to opportunities, needs and wants in their world for which possible solutions can be designed and produced (NSW Board of Studies, 2009).

Although these statements aim to evoke processes that demonstrate responsible decision making, careful choice and use of tools, resources and systems, they have been criticised for not identifying or classifying technologies specifically (Australian Association for Research in Education, 1993). As a result, there are many manifestations of technology that are simply too complex and often politically biased. Willoughby cautions that to define technology in “systematic or philosophically precise terms” (1990, pp. 25, 26) is problematic given the ubiquitous nature of technology and semantic variances, therefore it is not possible to isolate technology without referring to specialised terminology. Misa (2003) adds, the exponential rate of change of technologies that has occurred over time has evoked differing meanings between individuals and therefore “cannot be defined statically” (p. 7). Although academics such as Rogers (1997) declare it is possible to frame technology in “economic, anthropological, sociological, political or theological terms” (p. 10), Keirl posits that although perspectives may be identified through these disciplines this concept fails to identify potential understandings of technology within itself (2006). He muses that technology is such a “politically and educationally contested term” (p. 82) that there is a ‘business as usual’ ideology that remains unquestioned. Petrina adds:

These constructs serve as links between action and ideology - they serve to govern some economic, political or social course of action. They are socially distributed and shared ideologically across groups with contradictory articulations and meanings. They help to diffuse a range of motives with popular appeal. This is to say that these constructs are ‘always already’ political (Petrina, 2000a, p. 181).
Historically, definitions for technology have been bound up in reference to vocational manual skilling and specific tool application and training. Gassett (1972) for example defines technology as a basic feature associated with humanity. Throughout history, tool making and invention have brought about fundamental societal shifts in how we think, communicate, adapt and function in our environment – technology is thus an extension of ourselves and thus defines us. Yet the amalgamation of many technology educators, who have struggled to identify who they are and what it is they actually do, further compound the confusion in defining technology or what ought constitute an education in technology because technology as a term is ubiquitous (Autio & Hansen, 2002; Barak cited in Davies, 1999; Clark, 1989; Goodson cited in Davies & Hansen, 1998; Lawson, 2000; Lewis, 1991, 1996, 1999a, 1999b; Rennie & Jarvis, 1993; Seemann, 2000; Wicklein, 2006). A case in point was the difficulty introducing the interdisciplinary Design and Technology syllabus, also known as ‘technology education’ in Australia. As a new area of study, Design and Technology emerged through extraordinary educational and technological change during the 1990’s but failed in diffusion and acceptance due to multiple interpretations of its content and the difficulty for teachers to make a fundamental shift of knowledge and practice that was required (pers.com Senior DET Curriculum Advisor Technology, 2008).

In their review of technology education in schools, Allsop and Woolnough (1990) explain that technology has developed along four different lines, each with its own traditions and character. One approach is that dominated by craft teachers, a second is an approach focusing on hi-tech advances such as computers and electronics, a third approach presents technology as an engineering course at the secondary level, while a fourth views technology as a subset of science. Fensham (1990) has described how science education has gained an increasingly technological perspective in the 1980s and 1990s, and the word ‘technology’ is mainly used by science educators to refer to applied science (Rennie, 1987), a perception not shared by most industrial and craft teachers (Treagust & Rennie, 1993, p. 38).

During this period the expression ‘technological literacy’ unfolded with varying interpretations but was most commonly used interchangeably between technology and
computers. This was in part due to the “mass media and stock market traders using technology as a synonym for computers and information systems” (Nye, 2002, p. 1). Aside from the use of computers and the Internet as a means to “receive instruction about technology” (International Technology Education Society, 2007, p. vii), computers were seen as a core vehicle to improve literacy skills; thus reinforcing the word's unstable meaning and thus adding to the confusion of how technological literacy worked in practice (Rogers, 2005; Selfe, 1999). As a result, the word ‘technology’ has suffered confusion to the point where the most common view is that technology refers to using computers exclusively (Autio & Hansen, 2002; Spendlove and Hopper, 2004). On the other hand, the American International Technology Educators Association (ITEA) interprets technological literacy as a broad-brush curriculum capability involving Science, Technology, Engineering and Mathematics (STEM). However, Kelley (2010) and Williams (2009) highlight that the STEM acronym, in particular the ‘T’ in STEM, further dilutes and confuses technology education in the sense that “Engineering has a different type of relationship to Technology than does Science or Mathematics, because it is a sub-set of the broad area of technology” (Williams, 2009, p. 398) but instead strengthens the study of Engineering through computers.

If one reads the articles in depth, most of the examples of the T in STEM education are representative of informational technology or educational technology more than they reflect technology education practice. Moreover, when the national scorecard reports on STEM are examined, the T (technology) is measured by counting the number of computers schools had accessible for student use (Kelley, 2010, p. 4).

While common dictionary definitions have offered historic symbols for technology as industrial arts, fine arts, and later engineered sciences as a purposeful, commercial and systematic, technical and practical arrangement (Farrer, 2005; Fowler & Fowler, 1973; H.C. Wyld & E.H. Partridge, 1968, p. 1531; Kreb, 1981), more recently the Macquarie Dictionary (2011) primarily defined technology as “the branch of knowledge that deals
with science and engineering, or its practice, as applied to industry; applied science”. As technology involves such a broad scope of technology capability, the Macquarie Dictionary also defines technology as using computers and audiovisual equipment; equipment, tools and artifacts; economics as a means of production through knowledge; and technical nomenclature such as art or science.

However, a narrow view is compounded through general media newspapers that depict technology as working and living with computers, health and social networking or applications for computers (The Sydney Morning Herald, April 26, 2011). A Google Image search under the word ‘technology’ reveals images of computers and high technologies such as cell phones, application software apps, tablets, modems, Internet and digital cameras. The New York Times (April 26, 2011) and The Australian (April 26, 2011) also present technology as computer related, while the Financial Review (April 26, 2011) present technology as e-commerce, shares and copyright driven through computer software and Internet devices and applications.

While these descriptions reflect economic and technological time contexts, they fail to provide a common definition that embraces all technology over time. Technology is a way of thinking that combines knowledge, techniques and concepts as an intertwined relationship between people, technical activity and the environment (Australian Academy of Technological Sciences and Engineering, 2004). It is this embeddedness of technology in our world that defines our material culture. Thus it would be hard to imagine technology without some sort of resource being consumed (De Vore, 1980; Ihde, 1993a; Walker, 2000; Willoughby, 1990).
Material culture consists of the objects created in a given society its buildings, art, tools, toys, print and broadcast media, and other tangible objects. In the popular mind, material artefacts constitute culture because they can be collected in museums or archives and analyzed for what they represent. These objects are significant because of the meaning they are given (Anderson & Taylor, 2009, p. 27).

This thesis asserts that technology offers more than computer use or any other device and is best defined in a broader sense. When this thesis refers to technology it means to interpret technology in the broader sense of technology capability. Technacy is a term that accommodates this broad view of technology and is used in this thesis.

1.3.2 Defining Technacy

Technacy is an Australian expression that refers to the holistic understanding of technology; especially how the interrelationship between people, tool systems and the material environment are combined through processes of design to meet a purpose and a context of use. The original meaning associates itself with Australian Aboriginal’s ability to manipulate form in space as a three-dimensional expression or response to a need (Walker, 2000). Technacy evolved during the early 1980’s from work undertaken with remote Aboriginal communities through the Centre for Appropriate Technology in Alice Springs, Northern Territory, Australia. This frontier work in cross-cultural technology research, while not targeting technology education directly, did reveal technology choice; design and systems are values laden and contextual for their measure of relevance. Walker realised that transferred technologies are linked to culture and resources. It was concluded that the linear process of literacy followed by numeracy was an insufficient model of learning for indigenous people. Seemann was recruited as part of a national research project to investigate how technology knowledge in a cross-cultural setting ought be conceptualised, and developed the notion of cross-cultural technology education drawing
on a systemic or holistic frame of reference. The technacy concept was originally designed as an extension of literacy and numeracy with the core thesis to produce improved outcomes, in terms of literacy and numeracy, using a back loop approach with technacy.

When we originally put the term up on the board in the classroom we were seeing it as an extension of literacy and numeracy: What are the core skills that enable people to operate and evolve in a natural sense? You might get better outcomes in terms of literacy and numeracy if you focus on technacy aspects for what you are good at doing now, and work your way back and wrap your literacy and numeracy around technacy. Their abilities improved all-round. With technacy you can do things straight up. With literacy you have to go through all the bits of learning the alphabet, grammar and structure, you don’t have to do this with technacy. Instead you look at it from the other end (B. Walker, personal communication, December, 4, 2009).

Ancestral indigenous knowledge and socio-technical systems underpin technacy through the practice of being able to produce an artefact, tool or shelter that involves the integration of social, technical, material and environmental considerations. It is a nested system where each part defines the purpose and context and where each element is interdependent of each other to achieve a balanced outcome for technological activity (Turner & Seemann, 2010).

The Hansard report recommended that ‘technacy’ ought constitute part of basic educational provision (Commonwealth of Australia Employment Education Training, 1997). This directive followed on from the Australian Science Technology and Engineering Council which previously highlighted the need to incorporate technacy as a third element to literacy and numeracy:

For many years, literacy and numeracy have been the cornerstones of western industrialised education. Yet many people have questioned its adequacy for a more technological age that requires new skills in technology and problem solving. ASTEC proposes the framework for considering this is ‘technacy’. Technacy is a way of defining the meaning of ‘technological literacy’ that goes beyond competency in using technology. It refers to a holistic view of technology problem solving, communication and practice that includes consideration of social, ethical, technical and environmental resources and constraints (Australian Science Technology and Engineering Council, 1996, p. 6).
However, some scholars, such as Jenkins (1995), interpreted technacy as specifically associated with using and learning through computers. This he described as a new information skill that modern technology enables. Warren (1995), on the other hand, defined technacy as a third area of basic skill that works in tandem with literacy and numeracy, while Roy (1990) postulated that the word hinged on a fundamental literacy but declared the concept remained poorly specified due to the mixed variety of meanings. For example, Crawford (1998) and Solomon (1998) identified technacy as a social awareness for understanding advanced technological societies.

The Macquarie Dictionary Online (2011) defines technacy as an educational framework: 1) the holistic understanding of technology in relation to the creation, design and implementation of projects; 2) competency in scientific and technological problem solving, experimentation, communication; and 3) the ability to use this competency effectively.

Seemann (2001) expressed technacy as a holistic, integrated framework that looks at technology in terms of its generic form. Technacy permits the relationship between one form of technology to be compared with another, and to this extent technacy provides both a universal framework for understanding types of technological knowledge as well as a basis for their classification and comparison.

Technacy: is the ability to understand, negotiate and manipulate technologies and their applications in the world around us. This includes but is not limited to digitised technologies. It underpins the ability to use a telephone, an ATM or diagnose the cause of a leaking tap. Being technate implies the ability to engage critically with the environmental, human and technical aspects of technologies and the uses to which they are put. Technacy skills are as basic and critical to living in the 21st century as literacy and numeracy skills (ibid, p. 3).

The fundamental praxis of technacy considers access and equity, and ensures that social and environmental inputs are considered equally valid parts of science and technology decision-making processes (Seemann, 2000, 2000a). Technological activity involves a systems-thinking approach that includes mutually reliant relationships between people,
tools and the consumed environment, driven by purpose and contextual factors (Seemann, 2009). These three elements represent both resources and constraints evident in all forms of technological practice. Each element exists in a dependent relationship with the other elements of practice, defined via the purpose and context of application and can be measured in past, present and future contexts (Seemann, 2003, 2004a, 2009). Where an element is marginalised in favour of another, an unevenly distributed outcome prevails. Thus the objective is to arrive at a balanced view that acknowledges the heavy reliance technological choices and processes share with their social and ecological drivers. Technacy takes the position that technology education has a duty of truth to assure both ecological and sociological elements are carefully accounted for. The ideal is a net zero, or balanced outcome, where social and ecological benefits equal or exceed all other associated costs (Turner & Seemann, 2010). Although the framework has the capacity to harness creativity and is characterized as holistic, it does not accommodate a reductionist approach. Nevertheless, this thesis proposes that technacy is an appropriate framework in which to measure technological activity. When this thesis refers to technacy it is referring to the intellectual, practical and ethical dimensions that allow us to understand the educational value of technology (Seemann & Talbot, 1995).

1.3.3 Defining Food Technology

Food Science and Technology is the application of a range of scientific disciplines to understand foods and all their components and the application of the scientific knowledge so derived to the design, development and production of foods of consistently high quality (ibid, p.7).

The Education Providers Working Group of The Australian Institute Food Science and Technology (AIFST, 2009) define Food Technology as the application of food science to the selection, preservation, processing, packaging, distribution and use of safe food.

Collecting food science and technology information is complex and thus equally hard to
define because the industry encompasses layers of disciplines. A common problem is that many people, including educators, confuse traditional food education with food technology (Jideani & Jideani, 2010; KPA, 2003; Rutland & Barlex, 2009, 2005). The positioning of food technology in curriculum is an historical one that can be evaluated against social and economic contexts dating back to the 1800’s. This thesis maintains that the subject constitutes more than skill and drill cooking and consumption based activity, but rather embraces new knowledge and understanding in food properties and materials. Rutland (2009) reveals there has long been a standing tension between “food as a life skill and as a medium for teaching design & technology” (p. 2). The NSW years 7-10 Food Technology syllabi’s underlying principle of Food Technology is described for the purpose of this section in key terminology:

employment opportunities; nutritional quality of food, genetic engineering, functional food; environmental impact of food processes and vocational and general life experiences (NSW Board of Studies, 2003b, p. 8).

And for the senior study of Food Technology:

knowledge and activities; food needs and wants; provision and consumption of food; activities of human Endeavour; industrial settings; relevance to life (NSW Board of Studies, 2010a, p.6).

Collectively, these key terminologies reveal themselves through the social/cultural aspects of the syllabus, but the problem is the conflicting themes of study compared to a rationale in a higher education Food Technology syllabus:

basic sciences; point of production; handling; processing; preservation; distribution and marketing; consumption; utilisation by consumers; food processes; food commodities; food composition and food quality; sensory properties; safety and nutritional value (University NSW, 2011).

As our systems become more connected and sophisticated they display systemic behaviour, which means one cannot predict everything about it and one cannot control
everything about it either. Genre theory helps frame the complexities in Food Technology and this thesis defines Food Technology as ontology of technacy capability.

1. Human elements of practice: Food Technology knowledge, techniques and social organisation;
2. Tool elements of practice: Enabling food technology technical tools, devices and systems;
3. Material or ecological elements of practice: Consumable food ingredients, materials and properties, and their impact on ecology

Technology immediately shapes our behaviour. We know this through our personal technological experiences and observations. If we expect to enjoy a utopian life in the future we need to understand the future demands that are upon us. Accordingly, this thesis concerns the future demands of food sustainability and innovation and demand in that direction. This is the basis upon which conclusions are drawn and in doing so makes transparent any misconceptions around what people think food technology constitutes.

1.3.4 Defining Innovation

Innovation is a broad, complex and multifaceted term that is used freely throughout individual countries and associates with different meanings for an individual’s frame of reference or as an economic purpose in government policy, reports and curriculum reform (Australian Government Department Education Science Training, DEST, 2003; Ferrari, Cachia & Punie, 2009; Keirl, 2004; Moyle, 2010; MCEECODYA, 2008; Seemann, 2004; Sundbo, 1998). Fundamentally, innovation is often linked together with research (and innovation) or science (and innovation), and pertaining more specifically to “building knowledge-based economies and using technologies to build innovative programs”
Brief reviews of descriptions from both business and education sectors are presented in this section.

From an economic perspective, literature suggests innovation is essential in building a sustainable and productive economy. Schumpeter’s view for example connected ‘innovation’ with the patents of new products and/or processes (1934), while Roberts (1988) put forward that innovation involves invention and exploitation. Drucker (1994) later proposed innovation as a systematic and purposive activity, with Rogers (2003) further building on this research proposing that technological innovation occurs over time as a socio-cultural system – core to the idea or product’s success is determined through its successful diffusion into the market place. Consistent with this view, the Commonwealth Science and Industry Research Organisation (CSIRO) define innovation as the “smart application of knowledge to transform businesses” (2011, paragraph 1), yet it is the Organisation for Economic Co-operation and Development’s (OECD) definition that encapsulates innovation most succinctly and where much literature refers to. The OECD (2012) definition focuses on two main areas: human capital for innovation from a business perspective, and innovation in education and training systems. For both contexts, innovation is expressed as 1) product innovation, 2) process, 3) marketing innovation and 4) organization innovation.

The term ‘innovation’ in Australia is often used in a policy context with the purpose to improve the competiveness and productivity of national and local economies, yet education based literature presents a different definition context for innovation that involves teaching and learning and assessment, technology and often business services that offer professional learning support (NSW Government Department Education and Communities, n.d). While school education policies have rarely reviewed the economic concepts of innovation in the past, the economic language of innovation now permeates
these documents. Moyle (2010) further asserts creativity and imagination underpin innovation, thus from a teaching and learning perspective, nurturing students to learn constructively through trial and error processes will foster student capability and capacity building as a culture of innovation. However, Moyle suggests there is a tension between language and expectations in the policies regarding capacity building as a guiding process by teachers, which also involves the expectation to teach a “didactic concept of delivering content skills and knowledge” (2010, p. 16). This is compounded by two core aspects: 1) a focus on ‘teaching to test’ rather than developing a broader suite of skills that are more transferrable across different contexts, and 2) teaching innovation and creativity as ‘content areas’, rather than as an integrated approach consistent with “best practice-indicative practice – exploring the why and how, not just the what” (Fraser, 2007, p. 7).

Innovation by its nature is a creative endeavour yet the connection between creativity and innovation presents differing views in the literature. For example, Sternberg & Lubart (1999. P. 141) argue creativity is “used to reflect a psychological view at a personal level in contrast to innovation used in the world of business at an organisational level”. Kimbell, Miller, Bain, Wright, Wheeler & Stables (2002) on the other hand declare that innovation is ‘applied creativity’, while Hargreaves (2000, p.2) resonates a similar view in that “you can have creativity without innovation but you cannot have innovation without creativity”. Creativity involves the ability to synthesise, create new combinations from data, perceptions and materials and it also requires confidence and the ability to take risks. The nature of innovation is that it requires disciplined thinking, as does creativity, and a way forward in cultivating a culture of innovation is to develop suitable attributes in students that encourage creativity, initiative, enterprise and diverse ways of applying and using knowledge (DEST, 2003, p. xxii; Fraser, 2007).
However, the literature suggests that innovation has no single typical set of descriptors but rather many overlapping attributes, thus the capacity to innovate is determined through a suite of skills. DEST (2003, p. 5) and Moyle (2010, p. 29) outline key, desirable attributes individuals are expected to develop during the course of their general education:

- Communicate well
- Adapt to change

- Think originally and critically
- Work cooperatively

- Research capabilities and the ability to discern the veracity of information
- Risk taking and experimentation

- Remain motivated when faced with difficult circumstances
- Problem solving skills and finding solutions to problems as they occur

This thesis places its position in the most widely accepted frame that is most relevant to the research aims and questions, and that essentially the wider economic leaning for the term innovation demonstrates both behavioural as well as market uptake of new knowledge, products and processes. Innovation in the context of this thesis is construed as deliberate action to steer change and use it for beneficial results, and as such draws on business definitions due to its richness and close connection with economic drivers. This thesis makes the case for a need to engender a culture of scholarship in innovation education as this is a key area where there is a need to make a forward leap in order to move into a future where food sustainability and food innovation is important to global economic
growth and prosperity. To do this, the study of Food Technology needs to engender a culture for food innovation expertise as innovative and sustainability informed Food Technologists.

1.4 THESIS CONTENT STRUCTURE

The dissertation documents a study that was undertaken because there was a need to understand how well Food Technology in schooling offers a pathway into undergraduate food technology degrees. A novel theoretical view of events using a mixed method approach provided a lens with which to examine forms of technological knowledge. The use of a new data-gathering and analysis method for quantitative and qualitative data also contributes a new schema to the existing body of knowledge in the field of technology and food technology collectively. This section provides an overview of the chapters for the thesis.

1.4.1 Chapter 1: Introduction

This chapter outlined the context of the research that involves a long-standing problem concerning the poor transfer of students studying Food Technology in secondary schooling into higher education degrees in Food Technology. This chapter explained the factors that led to this study, discussed the need and impetus for the study and that the research holds significant relevance for informing curriculum and advances on various Australian food industry and government agenda. Forms of literacy were explored and the concept of technate individuals and Technacy Genre Theory was introduced. The research ethics was explained and the main research question and sub-questions were presented. The chapter continued by discussing the ambiguities and semantics associated with the various definitions of technology, technacy, food technology and innovation.
1.4.2 Chapter 2: Theoretical Framework and Methodology

Chapter 2 presents the research design and methods used to conduct the research. Technacy Genre Theory is identified as the most appropriate conceptual approach for the study because it allows common themes of philosophy and technological practice to be identified and compared with contemporary thinking and practice in technology education, and Food Technology specifically. In this chapter, sub-question a) of this research explores priority innovation and priority food policies and the temporal context of the changing political and economic landscape that involves demand drivers such as federal, state and government-industry linked initiatives, and supply drivers, such as state, school, teacher education, classroom culture and curriculum. Secondary Food Technology curriculum and food technology industry curriculum at a higher education level are compared in order to gauge the continuum of study from secondary schooling and the undergraduate study in food technology. The literature explores the ongoing debate between vocational skilling, scientific and technological applications. Part 2 of this chapter explains the research methodology that is structured around contextual (teachers and non teachers) and goal orientated (purpose) aspects of practice (technological understandings). The methodology uses a triangulation approach that involves fieldwork interviews, desktop literature research and qualitative and quantitative survey analysis. The key concepts of Technacy Genre Theory are an underlying theme and an influencing account of current perceptions in society today around technology education and food technology specifically.

1.4.3 Chapter 3: Analysis of Findings

This chapter presents the analysis of data collected from the questionnaires sent to the teacher and non-teacher groups. From a theoretical significance, Technacy Genre Theory
demonstrates that it is possible to create an indexing system that can distinguish between two different types of technology genre under the same label — Food Technology. The findings show powerful levels of significance in genre interdependent and co-relationships existing between food knowledge, techniques, ingredients and tools.

1.4.4 Chapter 4: Discussion

Chapter 4 discusses in more depth the key findings from Chapter 3 as a synthesis discussion. The comparative contexts (teacher training and non-teacher training) are discussed in relation to the general conclusions drawn from the literature and findings. The capacity for Technacy Genre Theory to act as an instrument to identify perceptions and values, and measure quantitative and qualitative data for identifying forms of technological knowledge and practice is reviewed and validated. Limitations and design efficiencies for the study are discussed.

1.4.5 Chapter 5: Conclusions and Recommendations

This chapter reflects on the research goals and questions, the theoretical framework and the research methods used. Recommendations resulting from the study are proposed and the significance of the study and possible future research are commented on.
CHAPTER 2: THEORETICAL FRAMEWORK AND METHODOLOGY

In any journey we should be concerned about where we are going, what vehicle is the appropriate one to use, how it is driven, and how we can tell when we have arrived (Hughes, 1973, p. 272).

To understand a model and judge its utility, it’s important to understand its purpose (Meadows, Randers & Meadows, 2004, p. 137).

In this chapter the theoretical framework and methodology for the study are presented in two sections. The first section broadly explores the phenomena attached to technological activity, its unique characteristics and its key concepts as they relate to innovation and design in technological knowledge: the thesis positions the study of Food Technology as one form of the wider field of technological studies. The thesis constructs a theoretical framework from a holistic perspective of technology to guide the methodology and design of methods considered appropriate for the selection, organisation and classification of data and observations. Embedded in this theoretical framework is the ontology of Technacy Genre Theory (Seemann, 2003, 2009) and principles of innovation as an integrative theme. While the literature may appear to be extensive, the significance of appreciating this direction of research is that it provides a basis to better inform teaching and learning practices of the universal form of all technological knowledge. The second section clarifies the link between the theoretical framework and the methodology employed.

2.1 THEORETICAL FRAMEWORK

The theoretical framework for this study in food technology and teacher education examined ideas and information from a technological context relevant to the research
questions posed in Chapter One. The task includes a conceptual frame for the types of empirical relationships examined in the research. The framework acts as an information gathering and organising device to ensure key aspects of information were not under or over emphasised (Reese Gandy & Grant, 2001; Smyth, 2004). Information gathering using an existing theory in Creswell’s view (1994), aims to test or validate the theory and thus becomes the organisational model for the research questions “to be scrutinised and tested, reviewed and reformed as a result of investigation” (Smyth, 2004, p. 2). In order to analyse the fundamental qualities of human technological activity from the literature, McMillan & Schumacher (2006), proposed that past events should to be explored as a way to understand current educational issues. Technacy Genre Theory was chosen to frame the research because the fundamental elements involving tools, materials and human agency, could be examined over time through the lens of purpose and context factors. The theoretical framework explored the ontology of technology as a start point to appreciate the intimate relationship humans have with their physical world both historically and in a contemporary sense. Selected theories and frameworks from a technological perspective were examined relevant to this research in order to identify key theorists in technology education and/or who may have conducted research in this area concerning food technology specifically. The purpose of food technology, innovation and teacher education were examined from an economic context pre and post 1900’s in order to understand the research problem: To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists?

Diagram 2 presents various parts that were reviewed as an approach in understanding why the problem exists and the resulting framework design for guiding a feasible solution.
Diagram 2: Visual organisational model for the theoretical framework

One of the most critical and under researched aspects of technological theories is the role of purpose and context. This thesis asserts there is a critical need to appreciate the key idea behind the ‘purpose’ drivers of technology choice and its development, and the ‘context’ factors that both overtly but mostly subliminally shape and define a great deal of individual and societal behaviour and perceptions. In addition, the economic and political landscape also infuses a crucial ingredient into the complexities of our designed world.

Willoughby (1990) explains that technology has long been transferred through trade, migration, art and craft, invasion, colonisation and religious domination. Furthermore, it is important that we understand the link between transferred technology and transferred technology education and training, both from an historical point of view and in terms of the role that education and training can play in the process of community development across different contexts. Willoughby (1990) suggests that if we accept that technology education and training is an integral part of community development, it should therefore be
directed towards assisting local people develop appropriate technologies and economic structures that will in turn empower them to become more productive and develop more sustainable livelihoods. The role this issue plays in policy formulation is significant as well as the assumptions constructed about their value (Seemann and Marinova, 2010).

A fundamental aspect of our capacity to transform our world through designed choices is not only evident across archaeological and climate change literature, but indeed is a fundamental aspect to humanity’s capacity to innovate and develop its identity... This co-evolution relationship extends to scales of human settlement design and choices, as much as it does across cultural, economic and geographic domains (ibid, p. 5).

This co-evolution effect, or “mutuality of influence” (ibid, p. 5), as a key idea needs to be explicit in schooling and critiqued in educational literature, as technology choice and transfer present implications for technology education and training across cultural boundaries. In the increasingly technologically complex world that we live in, evolve with, and from which we create, we need to better frame new societal and ecological system changes; there is a case to instill an ethic of respect towards our technology choices. Even subtle design changes in ordinary tools and devices deserve more deliberate thought than what we tend to afford to the task. For example, a hammer as a pounding tool can operate and look differently in different contexts. If something is jammed and you are in the bush, a rock can act as a hammer but looks different to what we know as a standardised hammer in western terms, i.e. long handle with an iron case hardened shape at the end. These design features should not be treated as trivial aspects but instead deserve conceptual examination because very few themes in technology, including food technology, can be adequately studied in isolation – purpose, context factors and inter-relationships become extremely important ideas in the proper study and education of, and in, Technology.
The following sections in this chapter explore key authors and readings in technology education and society with a particular interest in locating authors who have framed technology in terms of its ontology. The surrounding idea of how technologies are heavily influenced by interpretations of their purpose and context parameters, epistemological frames and orientated aspects of praxis in relation to human, tool and material factors are identified. If we do not understand what the ontology of technology is then we may not be teaching technology education properly and thus are more at risk of superficial or mis-educative pedagogy; we may only be looking at the utility of its effect rather than understand it – we may well be training up functionaries, but we may equally be neglecting a proper education in technology.

2.1.1 Understanding Technology

Critiquing the ontology of technology is a specialised theme in literature. This section of the thesis explores selected ideas by key scholars that cumulatively contribute to the discourse of what is meant when one asserts that one has developed an understanding of technology. Technology’s presence in our lives has become so embedded in our culture, economy and ecology that there is now a need to form a more coherent understanding of it because the risk of error in technological judgement is approaching planetary scales of consequence. The methodological goal of this thesis was to establish an operational understanding of the nature of technology as a key step towards developing a framework for examining the research questions this study has presented.

The growing body of literature around the philosophy of technology represents a diverse range of themes. The problem of understanding what technology is has had an adverse and often confusing effect on the study of it in schools. These differing perceptions have for the most part been presented in ad-hoc, and at times, in contradictory ways in educational
literature and curriculum. For example, expressions such as “Technological Literacy” may be interpreted as primarily meaning computer based skills, while elsewhere it may mean the spelling and labelling of technical terms and words, (NSW Board of Studies, 2003, 2003a 2003b, 2009) and elsewhere again to mean a general range of technological skills and ideas (Dugger, 2010). Little discourse exists that examines exactly what the form of technology is, in itself, and how that may guide rigor in technology education.

There has been a general consensus that technology is seen as an “archetypal black-box category of social science” (Lawson, 2007, p. 1). This view is consistent with the philosophy of technology literature due to the focus on social consequences, for example studies of ‘Technology in Society’ or the focus on ‘Technology Impact’ studies. Of interest to many schoolteachers is the strong international trend that subscribes to the view that technology constitutes transforming material into a physical object through the process of design. De Vries (1996) acknowledges the role of design in shaping practical capabilities and competences but qualifies the need to avoid a general design process format due to the design differences in the purpose and the context of a product’s specifications; for example, food design versus industrial design. In addition, science and technology are often used interchangeably. Some theorists claim technology has no relevance to science at all and as a result has created much debate around the nature of technology. This is expanded upon in section 2.1.2.2.

Ontology discourse has a long philosophical history that stems back to Greek and European philosophers who debated broad meanings for ways of knowing. Wartofsky (1980) points out that these early beginnings were driven through contextual differences of “value, belief and method in social, political, and economic life”, (p. 13) and where interpretations varied as the modes of social and technological praxis changed. Classical scholars such as Socrates theorised the idea of praxis and debated the purpose and types of
learning from the position of ‘techné’ versus ‘poiesis’. Plato developed a priori of principles from this concept, further refined through Aristotle’s first principles: 1) efficient cause, 2) material cause, and 3) formal cause (Brooks, 2006; Hansen, 2007; Nails, 2010; Silverman, 2010; Shields, 2005; Tighe, 2008; Wallach, 2009; Yu, 2005). Hegel’s work contributes further discourse by speculating that our thoughts are articulated through theoretical reasoning that progress through contradictions (Hegel & Miller, 1989; Ihde, 1993a; Redding, 2006;). This process involved triads that consist of: 1) thesis (proposition), 2) antithesis (alternative), and 3) synthesis (reasoned understanding).

Hegel’s work defines a significant step in building basic principles for holistic technology education because the idea, in his view was that our knowledge is derived through theoretical reasoning and that knowing constitutes ideas (Hegel & Miller, 1989).

However Feuerbach, a student of Hegel, rejected Hegel’s theory and instead asserted that ideas have their source in material experience. People are connected to the material environment through their senses, therefore practical experiences are necessary to construct knowledge. In the field of technology education, this transition of knowledge from being essentially one of total idealism to one where actual material-ecological experience is asserted to play an instrumental role in knowledge formation opens a key line of debate for teachers of technology beyond that as a subject designated for motor development. Dewey, following on the foundations laid by Marx’s seminal work on Historical Materialism and which formed the foundations to praxis, further advanced both Feuerbach and Hegel’s work. He asserted that intellect and practical applications needed to work in unison to achieve holistic and socially validated learning experiences (Chafy, 1997; Chagas, 2009; Dewey, 1938; Feenberg, 2010; Green 2006; Harvey, 2007; Loftus, 2009; Marx, 1967; Seemann, 2003; Wolff, 2007).
Husserl’s investigations of ‘intentionality’ is a relevant thread in the study of technology in as much that designing technologies assumes the presence in ordinary cases of an intention to act or a purpose to follow. Although Husserl attempted to define the phenomenon attached to the act of consciousness without drawing on assumptions from other philosophical traditions, essentially his theoretical position was that meaning and reality is acquired from our environment. This he termed ‘Phenomenological Ego’, and it only exists through cogitations that comprise all the acts of consciousness. Cognito therefore includes doubting, understanding and affirming, while Cogitata identifies that there must be something under consideration for thought to occur (Hankinson, 2005; Lawler, 2002; Sandmeyer, 2009; Welton, 2003). Husserl wanted to understand things present in consciousness and which could be experienced via the senses rather than in more abstract terms such as the notions of “atoms, electromagnetic flux or psychological motive” (Harmon, 2009, p. 2).

On the other hand followers of Husserl such as Heidegger, developed an alternate and esoteric interpretation that shifted toward a general ontology of technology rather than an epistemological view. He was more interested in how human beings constructed the meaning of their experiences through the constraints of their prior knowledge. Heidegger was more concerned with “being in the world rather than searching for the essence of the phenomena as an internal experience” (Vandevelde, 1996, p. 59). Although much of Husserl and Heidegger’s body of work is contradictory, the discourse permits some reflective understanding and meditative thinking given the complexity of human technological activity.

Dusek’s (2009) assessment of the evolution of the philosophy of technology was that as a field of inquiry it did not establish itself until well after the scientific and industrial revolutions. Founding thinkers in the sciences such as Descartes, Roger Bacon, Francis
Bacon and Karl Popper, by way of contrast, provided solid foundations for understanding scientific methodology and general science theories as categories of thought relevant to all disciplines. It was not until contemporary scholars, such as Ihde, highlighted the need to revisit core ideas underpinning technological knowledge, a topic of concern for scholars. Ihde’s work on the embodiment of technology in science validated technological knowledge was inherently context sensitive and therefore interdependent with conditionality (Hackett, 2009; Ihde, 1979; 1990; 1993; 1993a; 2009; Klein, 2004; Seemann, 2003; Smith, 2009; Urbach, 1987).

In the latter part of the 20th century, literature by Mumford (1963), Papanek (1984) and Schumacher (1999) voiced the problems of economics and scale of technology, and the consequence of technology transfer and design. Hansen (2007) offers ideas toward the case that the very nature of technology is largely determined by inherent potentialities, altering only in evolutionally steps that are based on social and other external, contextual influences. These views of technology raise the idea that we can choose to look at events from various perspectives. We are able to ask such questions such as, what would an artefact look like if it were examined from an economic or sociological perspective compared with a technological perspective? What indeed ought be the basis of a technological perspective in the first instance?

Mitcham (1994) argued the sociological perspective concerned social phenomena but furthered that engineering philosophy, being more scientific in nature, held more relevance about what technology is. It could be argued that engineering as mechanics, forces and metallurgy contain a technological purpose, but is this all there is to know about technology? Lawson (2007) emphasised from a sociological perspective that social activity constitutes technical actions that form an integral part of what technical objects are and how individuals react to the structural constraints and enablement that they present.
He added that, from an economic perspective, additional technological knowledge is not sought once knowledge of different production functions has been met. Lawson’s case in point was that technological considerations tend to be downplayed in many decision-making processes and usually at the expense of those decisions remaining sustainable in the longer term. What is missing is a basic education in the theory of technology to guide individuals in accommodating and directing actions during the process of design.

There is also an emerging view in the literature of the inherent political dimension to technologies and technology choices. Petrina (2000) advocates the need for a political consciousness for environmental awareness in technological education, while Keirl (2010) argues the need for democratic and ethical literacy in technology studies. Feenberg concedes that technology is an “ontological decision fraught with political consequences” (1999, p. 3), with the broader cultural values of historical and technical heritage ignored. Feenberg’s most significant piece of work in 2009, *The 10 Paradoxes*, describes technology as contradictory ontological traits: the nature of technology as being a form of existence that makes technology what it is. Although Feenberg has expressed in detail 10 Paradoxes, his broad statement for what technology is does not provide a reason why one phenomenon (technology) can produce so many paradoxes. Kurzweil (2001) concludes that we should no longer be complacent and warns ‘singularity’ will be the next fundamental shift that will re-shape human history — that is, society will evolve beyond current human social organisation and language norms — humans will co-evolve with technology and visa versa.

These concerns are valid in recognising technology’s effect on individuals and communities and the need to make ethical and sustainable choices. Yet little has been written about what it is about technology itself that requires us to engage in conversation
and writings in that technology has something to do with sustainability, ethics or political factors, or that it may have something to do with creating a preferred future for the betterment of humanity. Why is it that we need to see an association between technology and society, and technology and ecology? Why should technology have that association? Is it something about the ontology of technology that demands that relationship? How do we take a technological perspective on something and what is it one needs to do to satisfy the idea that we have taken a reasonable approach to having a technological perspective?

This thesis argues that while many critical and phenomenological theories provide a broad but dynamic philosophical discourse of the relationship between technology, society and the environment, theses theories fall short in making transparent what is common across all technology genre, thus defining it as a form of knowledge in itself. Wartofsky (1979) asserts that theories, or models, are a function of reductive explanation best applied on scientific grounds rather than a philosophical one. When a theory is applied as a framework it essentially organises symbols or thoughts as a way to understand and explain it to others. This thesis proposes that Technacy Genre theory underpins conceptual and praxeological understanding of technology as a universal framework for all its forms.

In summary, Technacy Theory’s basic principle finds its origins in Hegel, Feuerbach, and Marx, but more specifically in Ihde’s work, while Dewey shares interconnectedness in an educational context (Seemann, 2003). Technacy is a socio technical system able to identify patterns at different scales due to its fractal structure. The theory is able to guide the practitioner in understanding one’s technological practice (human agency) both inside and outside their own domain and thus critically engage with the environment through the use of tools. This is known as being ‘technate’ (Seemann & Talbot, 1995; Seemann, 2000, 2000a, 2010a; Northern Territory Government, 2003; Ramsey, 2004). Nevertheless, this

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2 These terminologies refer to the three Technacy lobes which frame this research: Human agency (society), Tools and equipment (technology), Materials and environmental drain (ecology).
theory has some limitations since the fundamental quality attends to the patterns of technological activity, it does not attend to patterns or qualities of innovation, although more recent work on Technacy Theory has proposed notions of improvisation and collaboration that Seemann (2009) argues form key ideas towards processes of innovation. Although innovation is relevant across a broad spectrum of organisations, the significance of innovation in relation to this thesis emerged from the literature as an economic and political factor connected to technical aspects in regard to demand terms (Druker, 1994; O’Sullivan & Dooley, 2009).

It is proposed that this framework has the capability for accommodating new understandings now evident in the subject matter and seeks to combine holistic ideas about technology with contemporary studies of human capacities in innovation. This chapter conveys the relevant currency for combining these two bodies of literature as an integrative framework that has the capacity to create a unifying method to inform the research methodology for this study. The following sections further explore the historical relationships and differences between technology and science and the unfolding of epistemologies up to the present.
2.1.2 Embeddedness of Technology in our Material Culture

As humanity and its technologies have progressed, they have also become more intertwined - until the contemporary notion of self extends far beyond bone and sinew, into outer space and cyberspace. Technology has become an essential part of who we take ourselves to be, influencing our beliefs and desires, our plans and goals, our visions of what we are, have been, and might yet become. Our identities are to a great extent determined by the roles we play. And these roles are often created and constrained by — if not wholly dependent upon — our technology. In its many forms, technology is both something we create — an expression of our understanding and our mastery of the world — and something that recreates us, fashioning new roles and reshaping old ones (Tripathi, 2004, para 1).

This section briefly examines the relationship humans have with their physical and digital world. While we define ourselves through shaping the world around us, that shaped world also influences how we think about our next actions. This section highlights the significance of how technological knowledge and technological action is more than just producing a device. It is actually about redefining the world that in return defines us. The world that people live in—particularly when comparing remote and rural parts of the continent to the city, a world of skyscrapers and traffic lights—have different stimulus cues guiding them when something should, or should not be done. It changes across different degrees of technological engagement to the extent that the made world around us, including the digital world, both influence us down a path of thinking and action that we normally do not seek to avoid because we seek its benefit. Underpinning the forms of technological knowing or innovation are a useful guide to differentiate critical factors in the continuing development of humanity, hence it is helpful to map social, economic and political contexts over time in order to recognise associations between human values, technology, scientific enquiry and the environment. In the following sections early praxis
is identified as a starting point, then the multidisciplinary context in which technology transfers itself is explored.

2.1.2.1 Early praxis in purpose and context

Human praxis, through the making and transforming of our material world, lies at the heart of how this thesis interprets technology. As a natural occurrence human praxis evolved from naturally available tools such as pebbles, stone, animal teeth and wood with the purpose of “achieving mastery over the forces of nature, animals or other human beings” (Mumford, 1967, p. 3). Ways of knowing and shaping our physical environment evolved through observations and imitation of other species, later beginning to learn communication through language and symbols (Davidson & McGrew, 2005; Derry & Williams, 1960; Gardner, 1990; Ihde, 1993a). This socially transmitted knowledge is evidence of pre-operational thought and thus the gradual development of behavioural modernity where more evolved and sophisticated tools replaced naturally available objects (Calvin, 2004; Damerow, 1998; Davidson & McGrew, 2005; Derry & Williams, 1960; Maynell, 2003; Mumford, 1967). The significance of this transition from sensori-motor to pre-operational intelligence reflected phenomenological patterns of human intentionality and the different ways humans experienced technology in their environment (Ihde, 1993a; Beaune, 2004; and Damerow, 1998). Although this is not a new concept, it is important to understand that technology can be presented in various forms and at various levels of sophistication. While this is valued in the archaeological and anthropological fields as a core idea, formal institutions—particularly large education systems—have almost lost or rejected fundamental relationships in the activity of human agency and technology practice as a context driven, value laden and ecologically dependent system (Dakers, 2005; Elshof, 2009; Keirl, 2010; Seemann, 2007).
It is important to take some time to consider the evolutionary phases that followed on from this period that involved a series of very long-term, diverse and overlapping technological transformations and scientific innovations up to the 20th century. These phases are fundamental in understanding that civilisation is not a singular whole but a technologically complex society that has evolved from primitive materials such as stone and wood to, sophisticated nanotechnologies, and in understanding human behaviour.

The next section is important to the literature because historically understanding the relationship between society, tools and materials, and the close relationship and differences technology has with science, has been weak in technology education (De Vries, 1996; Gagel, 2006). A basic schema is identified that considers both science and technology within a socio-environmental context.

2.1.2.2 Technology and science in purpose and context

Mumford (1963) asserts that technological and scientific development can be defined through three phases of different energy and material sources, thus determining the type of designed tools and equipment used. These phases also represent changes of human history and the purpose of knowledge and practice across different contexts. Collectively these were characterised as forming a “technological complex” (p. 109):

1) Eotechnic water driven wooden devices (9th -16th century)
2) Paleotechnic coal and iron tools and equipment (17th -18th century)
3) Neotechnic electricity and alloy instruments (19th -20th century)

The overlapping shift from the Upper Paleolithic era to the Agrarian era (referred to as the ‘Eotechnic Phase’) was driven through environmental conditions and eventually saw Western agricultural society structured under the Benedictine Order (Armelagos, Goodman & Jacobs 1991; Derry & Williams, 1960; Mumford, 1967; Olsson, 2001).
implementation of systems were developed initially for religious documents (6th century BC), but also as a means to keep records for business transactions and economic structures originally developed through planting and harvesting food and breeding livestock. The calendar was designed for agricultural purposes, while the use of water clocks (10th century BC) were instrumental in keeping time, keeping track and keeping society in order (Armelagos et al, 1991; Mumford, 1963; Olsson, 2001).

The 9th-16th century Western culture was primarily an agricultural society in which the economy moved at a “slowly accelerating pace” (Geddes, 1915, p. 60), although ‘capitalist’ discourse is often related to the Industrial era (referred to as the Paleotechnic phase) this term also finds associations, although more balanced, in the Eotechnic society (Derry & Williams, 1960; Mumford, 1963; Pike, 1966; Riello & O’Brien, 2009). Handicraft items were of a common technology that is still practised in today’s schooling in various offshoot genre forms (metalwork, woodwork, textiles). Education was focused on transmitting knowledge and skills to the younger generation within the village and where learning skills were closely linked to common sense and spiritual well being through family connectedness and cooking. This localised system weakened during the 17th – 18th centuries as the Industrial Revolution advanced (Chafy, 1997; Rogers, 1997). The relationship between ‘supply’ and ‘demand’ shaped society by the evolution of its artefacts and was directly linked to economic, political, religious and cultural aspects (Gagel, 2006). This key aspect in understanding critical social and political structures in society and the connection to tools and materials is a significant theme in the study of technology — fruitful discussion cannot take place without the recognition of past events and how it has shaped the present day. Greek metaphysical origins are another example in understanding modern science and the connection with technology. Experiments entailed technologies or instruments against which, and in relation to which, phenomenon was compared (Popper,
Without Copernicus and Galileo’s exploratory work, Roger Bacon’s independent scientific inquiry may not have developed the binocular lens (Hackett, 2009; Machamer, 2005; Rabin, 2005).

Comte on the other hand, excluded pure metaphysic speculations and emerged as the founder of positivism, a new concept that used scientific data methods. His assertion was that knowledge was based on observable facts and data, viewed as phases the mind would work through to understand behaviour. For example, theological, metaphysical and objectivity through reasoning and observation helped progress the idea that phenomena as an inquiry uses technology, intellect and the senses (Bourdeau, 2008; Dusek, 2009; Ihde, 2009; Radder, 2009). High moments of theoretical scientific advancement occurred through an explosion of technological innovations that resulted in scientifically derived technologies and a simultaneous move toward understanding theories of organic and non-organic molecular structures. It is important to note that this was a divergent process to previous centuries where materials were transformed without knowledge or theory of the molecular matter. This change from the macro to the micro level was made possible through former key innovations such as the scientific experiments for optics, the improvement of glass manufacturing and the design of the microscope and telescope (Ihde, 1993; Mumford, 1967).

Ihde, (1993) and de Vries (1996) remind us that technological ways of knowing were evident well before scientific ways of knowing; for example, thermodynamics followed the invention of the steam engine, but technology was “essentially and necessarily” embodied in modern science and as such played an important role in the trajectory of enquiry (Ihde, 1993a, p. 74). Although there is a strong symbiotic relationship between science and technology, Seemann (2009a) adds there are also important differences between the goals, methods and skills, each maintaining its own integrity and uniqueness. Where science
tests ideas against one another, technology tests how an idea works in a key purpose and context (Appendix 2). Where science seeks to understand what exists in the natural world and is underpinned by technology through the use of equipment, technology extends our ability to meet human needs and wants through modifying the natural world through our hands, voices and senses. One of the core problems Dugger (2010) highlights in the uptake of technology education is the confusion between science and technology. He adds that technology as a subject is associated with particular processes such as, “invention”, “innovation”, “practical problem solving” and “design”; terms that differentiate itself from science (ibid, p. 6).

In its most basic meaning, technology is the modification of the natural world to meet certain human needs and wants. Technology helps us to extend our abilities by improving our health; growing and processing food and fibre; harnessing and using energy; communicating more effectively; processing data and information faster and more efficiently; moving people and things farther and quicker; producing products; building structures and environs; and other activities (ibid 2010b, p. 3).

Ihde’s work in phenomenological praxis identified that a more complex paradigm evolves through the interaction of instruments or artefacts that in turn modifies that experience between human beings and their life-world. Seemann, (2003, p. 5) illustrates below independent human activity as a natural phenomenon with the environment such as seeing through our eyes to view phenomena.

$$\text{Human (Agent) World} \quad \leftrightarrow \quad (\text{Environment})$$

This key notion from Human (agent) and World (environment) to involve Artefact (tool) thus constructs a schema for basic principles in technology education (Diagram 3).
Diagram 4 illustrates an example using a microscope to view phenomena, thus changing the experience in what we see, because feedback comes via an instrument rather than from the observer directly. Seemann emphasises the context specific nature of technologies and thus the transition of technology to a values rich domain due to their “cause and effect tendency” (2003, p. 5). This is particularly important in technology choice and transfer in applied settings. Understanding the concept of purpose and context provides a measure to give process a meaning and because the elements or lobes (tools, materials and human agency) are interdependent, become the minimum fundamental requirements for teaching technology education. To produce an artefact, tool or a shelter means to integrate all three forms of knowledge (Seemann, 2003 p. 5).
Conversely, de Vries (1996) posited the need to structure relationships between science and technology as a way to build a sound educational research base for technology education and technology teacher training:

Another need for technology education in terms of the science-technology relationship is educational research with respect to how pupils see this relationship and how their ideas may be changed in technology education. In general, the educational research basis for technology still needs to be strengthened and extended. Here a lot can be gained from experiences in science education, where many studies into the conceptions that pupils have of scientific concepts and principles have been reported (ibid, para 20).

De Vries suggests that the debate surrounding whether or not it is possible to define a body of knowledge and skills called ‘technology’ remains largely unresolved and as such further research was required. This thesis demonstrates different types of technology can be identified and that Technacy Genre Theory has the scope to provide a framework for considering both science and technology within a social-environmental context. Yet the on-going development of the globalised world today would not be possible without the technological developments over past centuries. Diamond emphasises:

Technology’s history exemplifies what is termed an autocatalytic process: that is, one that speeds up at a rate that increases with time, because the process catalyzes itself. The explosion of technology since the Industrial Revolution impresses us today, but the medieval explosion was equally impressive compared to that of the Bronze Age, which in turn dwarfed that of the Upper Palaeolithic. One reason why technology tends to catalyse itself is that advances depend upon previous mastery of simpler problems (ibid, 1998, p. 258).

In particular the emergence of electronic connectivity during the latter part of the twentieth century turned knowledge and communication transfer into a global and ubiquitous phenomena at an exponential rate for the twenty first century. This was made possible through information and communication technologies that transported knowledge through digital applications, thus re-shaping the world through massive changes between human cultures and social systems. Trading moved to a politically driven global context,
manufacturing shifted from first world to third world countries with a subsequent surge of economic growth occurring, particularly in the Asia-Pacific region.

The following sections examine selected theories and frameworks from the literature relevant to science, technology and education. Of particular interest is the unfolding of the epistemologies or ‘ways of knowing’ up to the present. These may not specifically examine the principles underpinning forms of technological knowing or innovation, but rather identify and further explain another purpose and thus presents the general theoretical concepts that underpin Technacy Theory.

2.1.3 Social and Environmental Systems Analysis

2.1.3.1 Pre 1900’s in purpose and context

This thesis was approached from a holistic perspective by combining the multifaceted aspects of technology, food technology and teacher education. This section of the study reviews important ideas in human history that have contributed to the view that engagement with the material world provided a basis for knowledge about it – a theme fundamental to technology education. Works of interest to this thesis begin with ideas proposing that there is a difference between theoretical and practical understandings (Dakers, 2005; Dusek, 2009). A great deal of technological knowledge requires many wider contextual parameters to be accommodated in the final design and production of things and systems. For example, how to develop a product or system that meets the needs of intended users within an acceptable range of conditions. To this end, designers often work from the wider view to the specific one. For example, Thales’s deductive reasoning technique offers a useful method in technology education to explain concepts ranging from the general to the specific (Curd, 2007; De Santo, Bisaccia, Bilancio, Romano & Cirillo,
Furthermore, purposeful creativity often demands of technologists that they resolve competing ideas having to solve problems that emerge in attempts to find the best fit to the contextual parameters under which the technological solution must successfully perform.

Socrates is suggested to have played an important role in technology education for various reasons. Although Socrates’ critique of democracy is well documented, his use of a dialectic approach to initiate an individual’s self discovery of knowledge is drawn on by many contemporary educators (Dakers, 2005a; Ihde, 1993a; Nails, 2010; Popper, 2002; Silverman, 2010; Yu, 2005). Socrates' also held the view that while he accepted that there was general knowledge for the crafts, he regarded craft knowledge as consisting primarily of a technical understanding, thus limiting its concern to the pursuit of particular trades or practices (Dakers, 2005). Socrates’ techné versus poiesis position has manifested much discourse and debate surrounding technology education because of the historical meanings of these words. According to Dakers, techné associates with trade skills, whereas poiesis associates with skilling the mind i.e. calculative and expressive thought (Appendix 3). This thesis examines the view that the narrow process of ‘doing’ and ‘making’ things is more favoured in technology education, rather than fostering a wider critical awareness of the embeddedness of technology in our social and ecological world (Dakers, 2005, 2005a; Williams, 2000; Tiles, 2009; Verbeek & Vermaas, 2009).

On the other hand, Plato’s interest in forms of knowledge helped develop systematic theories of education and the basic ground rules for educational and philosophical thought still evident today (Bowen & Hobson, 1987). Plato advocated priori principles based on an analogy of intellect that advocated natural science and material-object relationships. Plato’s metaphysical views were more than mental constructions, but rather a real and timeless existence as a comprehensive philosophy (Dusek, 2009; Ihde, 1993a; Popper,
Where Plato was an idealist, Aristotle was a realist and both debated the purpose and types of human learning. Aristotle rejected Plato’s idealist approach and instead advocated a more practical approach to metaphysics (Bowen & Hobson, 1987). Aristotle proposed explanations for observed phenomena as four elements involving earth, air, fire and water – these four elements represented first principles of all things that offered logical discourse and explanations about phenomena. However, these deductions were purely hypothetical and unsubstantiated by experimental testing (Hawking & Mlodinow, 2010; Popper, 2002; Tighe, 2008). Aristotle’s notion that form and matter (art as object) contained a purpose through human agency and structured these factors as causalities: 1) efficient cause (human agency), 2) formal cause (object) 3) material cause (organic), and 4) final cause (purpose or goal). Aristotle declared these ‘causes’ as interdependent, that one cause could not be explained without the other. His use of art as object suggests that this was naturally, not rationally, inclined to a technological perspective of causality (Shields, 2005; Lee, 2009 and Verbeek & Vermaas, 2009).

Diagram 5: Aristotle’s triad for causes

A key position in relation to teaching and learning requires explicit learning experiences that link and define the elements of ‘causes’ as an interconnected schema. In doing so the schema reinforces a more holistic base for understanding design and technology decision processes. Although Aristotle’s theory lacked the capacity to predict nor always agree
with the observation, his work concerning “the act of intuitive reason” (Bowen & Hobson, 1987, p. 82) offers an important concept for technology education. The creative act of shaping the world to facilitate meeting a need was understood by Aristotle to be innate to humans, and thus consistent with ‘intuitive reason’.

Descartes’ work linking the impact emotions have upon internal perceptions of causality is well documented (Dakers, 2005). Weiner’s attribution theory, for example, builds on Descartes’ work by providing a framework for explaining these different responses through internal and external factors (1986; 2000). This poses an interesting aspect to the literature concerning the motivation or desire to explore new ways of learning for teachers and students. Understanding these innate patterns help progress the type of innovation attributes required for continued scholarship in the field of technology education where new knowledge and techniques are now emerging at a rate that may for practical purposes be conceptualised as continual evolution, and indeed, ongoing emergence. Relative to other fields of knowledge and subject matter in the curriculum, there is a case to assert that Technology Educators would be well served to actively engage in an ethic where the exploration of, and openness to, new knowledge becomes the default signature of their professional disposition. The challenge in this field of practice, however, often suggests the opposite is the norm. In the authors experience, the profession’s interest for emergent knowledge and pursuit of its evolution, seems much more a conservative trait and in some educational systems, defensively protected as so.

Conversely, Hegel’s idealism and dialectic view, while not sufficient to conceptualise a coherent understanding of material knowledge, nevertheless has provided a key step towards a theoretical frame relevant to this study because his philosophy articulated a basis for reasoned thought as a coherent way to form knowledge about the world. While Hegel’s model of reasoning has been well referenced, scholars have also identified flaws in
his approach. Popper (2002) declared Hegel’s thesis did not consider evolution, motion or development, Popper conceded his thesis inferred “that since reason develops, the world must develop, and since the development of thought or reason is a dialectic one, the world must also develop in dialectic triads” (p. 439). This idealist reasoning was a process where each triad consisted of thesis, antithesis, and synthesis. These opposites represented propositions of consciousness that categorised thought for our social existence. When all three are understood to be interdependent as a coherent system, reasoned understanding would be formed (Ihde, 1993a; Thomson, 2009; Redding, 2006; Seemann, 2003).

Diagram 6: Hegel’s triad for reasoning

Thus, Hegel’s phenomenological model of ‘mind’ offered some important ideas towards a reasoned understanding of the world within which we exist, but it fell short of acknowledging the need to engage with the material physical world as essential for knowledge to form – in technology education, engagement with the world tends to be a key feature of its value. Feuerbach, a student of Hegel, rejected Hegel’s idealism. He defined the world beyond our consciousness as a material one that exists without us and from which we draw ideas almost entirely. Feuerbach proposed the mind and body as one organism, connected to the environment through the senses, and that to construct knowledge requires that we engage our senses with the world in practical activity
Feuerbach’s materialist rather than idealist view distinguished between consciousness and self-consciousness and as such placed material objects over ideas. Furthermore this idea contains an important principle for technological understandings through tactile experiences (Chagas, 2009; Harvey, 2007; Loftus, 2009; Marx, 1974; Seemann, 2003).

In many ways, Feuerbach was the antithesis of Hegel, and while both offered important ideas towards a basis for technological knowledge, it was not until Marx proposed his resolution of their opposing views in his model of Historical Materialism (also later popularised as praxis) that robust theoretical foundations for unveiling the form of technological knowledge was able to be articulated (Seemann, 2003). Marx also criticised the politics of capitalism for its inadequacy to ensure human civilisation was healthy in both a social and ecological sense. A key idea of Marx was the necessary mutual and socially contextualised transformation that occurs as people shape and transform the world within which they live; that is, that people represent ‘agency’, display ‘intentions’ and can reflect on their engagement with the world. In this process, the craft of ‘material’ engagement and reflections upon that engagement necessitated the formation of new or reinforced knowledge as well evidence of a changed world before them. This mutual transformation idea is a very powerful one, and serves well the foundations of how technological knowledge does indeed have a case for being a unique form of knowing that can be observed and contested for validation and transference of method (Seemann, 2009). Historical materialism therefore is a foundation to more contemporary ideas such as praxis because individuals always engaged in degrees of technical activities that necessitate a relationship between people, technical activity, and the material environment within a socio-cultural and historical context (Dusek, 2009; Ihde, 1993a; Scubla, 2009; Seemann, 2003).

We have seen how, on the assumption that private property has been positively superseded, man produces man, himself and then other men;
how the object, which is the direct activity of his personality, is at the same time his existence for other men and their existence of him. Similarly, the material of labour and man himself as a subject are the starting point as well as the result of this movement (and because there must be this starting point private property is an historical necessity). Therefore, the social character is the universal character of the whole movement; as society itself produces man as man, so it is produced by him. Activity and mind are social in their content as well as in their origin; they are social activity and social mind (Marx, 1967, p. 129).

Marx’s work also highlights the importance of the applied setting. The effect technical activity has through human agency provides a specific link for the technology educator as a way to enable meaningful experiences that make explicit material and environmental interconnections. The next section moves into a post 1900’s context where the sciences gradually separated from the humanities. Philosophy evolved to a metaphysical systems approach, while the sciences marked the beginning of empiricism. Technology, on the other hand, was viewed as separate and always remained a background phenomenon (Mumford, 1963). This section specifically explores science and technology scholars and the philosophical contributions they bring to contemporary technology education.

2.1.3.2 Post 1900’s in purpose and context

The idea of the relationship between people and their technical activities was not new to Heidegger or Dewey, both pioneers in the philosophy of technology (Ihde, 1993a). Heidegger’s core interest in people ‘being’ and objects ‘beings’ emerged under the influence of Husserl (Feenberg, 2010). Although grounded in metaphysical philosophy, Husserl’s work contains a labyrinth of ideas that convey twists and turns between his earlier works to that of his later scholarly offerings, so it is very difficult to define his work explicitly without engaging across the entirety of the body of his work. Vandevelde (1996) concedes that Husserl was realistic (sensible, practical and reasonable) in 1901, but idealistic (naïve, impractical and unrealistic) in 1911. Welton (2003, p. 7) summarised Husserl’s rejection around the conception at the turn of the century that philosophy ‘was
not a science but a “worldview”. Husserl described the phenomena of experience as consciousness, thinking and the element of intentionality. This was framed through: 1) Phenomenological Ego, where meaning and reality were acquired from our environment; 2) Cognito involved all acts of consciousness; and 3) Cogitata involved subjects of thought or objects of consideration.

Diagram 7: Husserl’s triad for understanding phenomenon

Husserl’s work has varied incarnations but the expectation or prediction of an occurrence, or the “Aha moment” is referred to the most in earlier literature (Papanek, 1977, p. 154). These are interdependent moments of a concurrent experience but do not necessarily take place simultaneously (Edelheim, 2007; 1994; Zahavi, 2003). In an implicit or un-thematic manner we always anticipate that which is about to happen and as such anticipation forms a part of an experience. Thus Husserl would claim that the full structure of pre-reflective self-awareness is a primal impression-retention-protention act (Zahavi, 2003, p. 11). This work is important to the literature because human consciousness results in introspection, a new dimension of consciousness that rises to another level of reflection and analysis. One of the most emergent changes in the NSW Professional Teaching Standards at Graduate Level is the need for students to demonstrate the “Capacity to analyse and reflect on practice” (NSWIT, 2010, p. 12) and as such model these same attributes to their future students.
Like Husserl, Heidegger also hypothesised Western metaphysics to be inadequate as a philosophical enquiry and thus deconstructed praxis thinking from a science-technology position to a technology-science relationship (Ihde, 2009). His ontological position questioned the complexities between people and the specific purpose of technology use and resources from nature. He posited a holistic model for technologies given the heavy emphasis of technology use during the industrial revolution and where humans had a duty of care through their own choice (Dakers, 2005; Holcombe, 2007; Ihde, 1993a; Karpowicz, 2009). According to Feenberg (2010), Dusek, (2009) and Scharff (2009), much of Heidegger’s work used enframing as a concept to understand being (human nature) and beings (objects):

> The version of the concept of enframing conforms to a tendency in Heidegger’s works to treat the history of being as a succession of universal principles of intelligibility. Each epoch is characterised by the way in which beings are given according to such a principle. Thus enframing is not simply a widespread “problem” we could solve with appropriate remedies, but the underlying structure of being in our time (Feenberg, 2010, p. 2).

However, Feenberg argues much of Heidegger’s text ‘the question concerning technology’ is contradictory, although the discourse permits some reflective understanding and meditative thinking given the complexity of human technological activity — “Thus, in a formal capacity man stands outside of the enframing even as he continues to enframe himself daily and to drive the enframed world forward” (ibid p. 5). Edelheim (2007) explains that in order for human beings to construct meaning of their experiences, they need to be interpretative people who can understand their surroundings within the parameters of previously gained information. Heidegger’s concepts advanced the relationship between technology and human identity and it would be erroneous to reduce his concepts to merely object and device status and thus should not be ignored; but rather it has a place as an area of study as the educational relationship pertains to transforming the
development of the child through identity and thus allows for certain characteristics to be nurtured and developed in the learner.

A significant thinker for the field of Design and Technology knowledge is the educationist, John Dewey. Dewey examined the critical relationship between the hand and the mind. While he acknowledged hands-on skills were important industry demands, Dewey argued the critical relationship between the hand and the mind as an essential activity for the development of a child (Chafy, 1997; Dewey, 1938; Leddy, 2007). He perceived character and disposition as important and to be able to critically analyse and reflect on processes rather than be confined to “technical and specialised things” (Dewey, 1936, p. 209). His ethical and political thinking pushed individual freedom as a democratic right, as educational institutions in Dewey’s mind were meant to create individuals who were free to develop their capabilities and so express their resourcefulness. Dewey believed the purpose of education was to transform society rather than reproduce it but a core ethic of teachers were required who possessed a disposition for open-mindedness. In Dewey’s view, this quality was an essential ingredient to assure evolutionary development and a mind that could welcome change. Intellectual growth meant a constant expansion of opportunities that consequently formed new ideas, purpose and responses. His thoughts reveal criticism of teachers as having a stubbornness of mind and where their development had become stagnant because they had shut themselves off from new stimuli … “closed mindedness means premature intellectual old age” (Dewey, 1916, p. 206). In light of this, human inquiry and knowledge as a problem solving, praxical action were seen as the core vehicle to nurture individual potential rather than shaping students to a pre-conceived pattern (Bowen & Hobson, 1987, p. 82).

The cobbler, the flute player, the soldier, have undergone the discipline of experience to acquire the skill they have. This means that the bodily organs, particularly the senses, have had repeated contact with things and that the result of these contacts has been preserved and consolidated
until ability in foresight and in practice had been secured. Such was the essential meaning of the term “empirical”. It suggested a knowledge and an ability not based upon insight into principles, but expressing the result of a large number of separate trials. It expressed the idea now conveyed by “method of trial and error”, with especial emphasis upon the more or less accidental character of the trials. So far as ability of control, of management, was concerned, it amounted to rule-of-thumb procedure, to routine (Dewey, 1916, p. 308).

A number of philosophers influenced Dewey, such as Kant and Hegel, but Dewey’s interest in experimental science overshadowed the Hegelian idealism. Dewey drew on Kant’s ‘schema’ concept describing it as “a collective of discursive characteristics that become a schema” (Welton, 2003, p. 97). His interest in instrumentalism provided a descriptive appellation for his theory between organism and environment. He argued that the organism (human) interacts with the environment (world) through self-guided activity where sensory and motor responses are assimilated. Dewey hypothesised knowledge was not passive, but perceived through interaction and experimentation using the method of science and ethical, reflective thinking (Dewey, 1938).

Lewin (1948) furthered Dewey’s work concerning the integration of theory and practice. He considered experiential learning as an action and reflective process and central to a person’s experience in any activity. In the process of learning and reflective practice, Kolb (1984) discussed the association between feelings and emotion that students bring with them in the learning activity. For example, personal values, free and informed choice and internal commitment. He viewed these attributes as a part of the learning cycle. Conversely, Boud’s work advocated experiential learning stages where there is some kind of preparation done before a learning event. He believed that preparation beforehand increased the learning experience and that intentional learners who had a specific goal in mind were more likely to reflect on their learning experience. However, Boud, Cohen and Walker (1996) highlight there are barriers to learning where factors may inhibit learning and a leaner’s ability to reflect rationally with the view to learn from the experience. The
essence of technology education is its experiential and existential nature and thus important concepts that further build upon basic principles for technology education — practice informs knowledge through the interaction of the mind and the hand. Hansen (2007) adds that many educational philosophers had not clearly identified how people learn but rather explained content and processes that would support learning. Consequently, “their views had little impact on school leaders and programs” at the time (p. 89). It would be many years later that educational research in teaching and learning would recognise the need for a holistic education model.

Experiences in life and our interpretations from those experiences determine our values and shape how we think. Schumacher declared in 1999, a core problem that has propagated many issues in real world contexts is derivative from formal education. Schumacher advocated a “tool-box-of powerful ideas” (p. 64) is needed to help clarify our central convictions and make sense of the world through ethical and values laden judgements. Instead, education has evolved into a fragmented system that is very good at “rearranging tools in a tool box” (Minzy cited in Otero & Townsend, 1986, p. 4) and as such fails to deliver dynamic, holistic and critical strengths that benefit students (Keirl, 2000). While science, and engineering for example may produce “know-how”, in technology education “know how is nothing by itself”, and while curriculum ignores underlying principles that form the basis of particular fields of knowledge but promotes generalisation instead, the educational value of subjects will remain superficial and disjointed to real world contexts (Schumacher, 1999).

Know-how is nothing by itself; it is a means without an end, a mere potentiality, an unfinished sentence. “Know-how” is no more a culture than a piano is music. Can education help us to finish the sentence, to turn the potentiality into a reality to the benefit of man? To do so, the task of education would be, first and foremost, the transmission of ideas of value, of what to do with our lives. There is no doubt also the need to transmit know-how but this must take second place, for it is obviously somewhat foolhardy to put great powers into the hands of
people without making sure that they have a reasonable idea of what to do with them. At present, there can be little doubt that the whole of mankind is in mortal danger, not because we are short of scientific and technological know-how, but because we tend to use it destructively, without wisdom. More education can help us only if it produces more wisdom (Schumacher, 1999, p. 61).

Also relevant to technology education is the historical demarcation between science and metaphysics, largely orchestrated through Karl Popper’s work that advanced empirical falsification. He questioned the validity of inductive logic and disputed metaphysical scientific ‘laws’ as they could not be scientifically proved. In Popper’s view, and although he thought metaphysics an interesting philosophy, these theories could not be claimed as scientific knowledge but rather conjectures that were non-testable in unpredictable human behaviours (Popper, 2002; Boon, 2009; Dupuy, 2009). Popper held the view that any theory or tentative hypotheses could be falsified or refuted.

The principle of empiricism can be fully preserved, since the fate of a theory, its acceptance or rejection, is decided by observation and experiment-by the result of tests. So long as a theory stands up to the severest tests we can design, it is accepted; if it does not, it is rejected. But it is never inferred, in any sense, from the empirical evidence. There is neither a psychological nor a logical induction. Only the falsity of the theory can be inferred from empirical evidence, and this inference is a purely deductive one (ibid, p. 72).

This area of literature is important as it contains an educational interest in relation to the NSW Stage 6 Design and Technology syllabi. Students are expected to engage in research through the development of a Major Design Project through “analysing, interpreting and applying research data to the development of design projects” (NSW Board of Studies, 1999, p. 17). Popper’s literary works would be useful as a textbook to better inform understandings of research methods in design practice.

Educationists have long debated the need to question the common approach in teaching technology education as a series of mapped out steps of production under the guise of design and problem solving (Petrina, 1998; Williams, 2000). Elsholf calls this “artefactual’ knowing” (2007, p. 179) and emphasises formal education systems are
entrenched by instrumentalist and deterministic frameworks. In a world of expeditious change and of great demand, it is timely to rethink traditional approaches and to adopt different understandings in cognitive science that allow for diverse ways of applying and using knowledge. The capacity for abstraction and the ability to problem solve are noted as essential attributes for knowledge and innovation capacity building as the workplace shifts from the reliance of physical tools to mental tools. Fee and Seemann (2002, p. 5) conceptualise this as these tools as:

1) Software – expressed as ‘explicit knowledge’: codified and transmittable knowledge; the ability to articulate knowledge and record it through words, numbers, codes or scientific formula. This is classed as easy to store and communicate knowledge.

2) Wetware – expressed as tacit knowledge: based on internalised information such as emotions, experiences, insights, intuition or observations.

Tacit knowledge is seen as an aspect of, and so inclusive of, the broader class of human agency. Research in cognitive science also positions Fluid Intelligence as key to entrepreneurial activity, which Belsky (1990) identifies as ‘on the spot reasoning ability’. This type of intelligence requires abstract thinking capabilities and is considered independent of our known experiences (Wagner & Sternberg, 1985). The antithesis, Crystallised Intelligence, requires practice built upon prior knowledge to execute a task. Although both Fluid and Crystallised intelligences can be complementary, a bias toward Crystallised Intelligence more often than not results in poor cognitive learning outcomes (Horn & Cattell, 1967).

We can contrast problem solving that demands fluid intelligence with problem solving that demands crystallised intelligence. It is asserted most technology teachers are well acculturated in teaching students how to draw on their crystallised intelligence where typically the teacher
assumes a student must be ‘filled’ with tool and technique skills before they are capable of creatively developing solutions to tasks set: the need to predetermine the solution by assuming required manual skills first before a designed solution is developed. Fluid intelligence is well placed for innovation development; whereas crystallised intelligence is traditionally placed for crafted production (Seemann, 2004a, p. 102).

The ongoing debate between vocational skilling, scientific and technological applications stimulates interesting discourse surrounding technology education today. This section examined the critical relationship between theoretical and practical understandings in science and technology contexts, and the purpose of developing learner attributes. While knowledge has always been important, rapid economic shifts in contemporary society require more innovators in this area for our future through education, and science and technology research. The next section examines the purpose and context factors associated with the knowledge economy and innovation. Key theorists are discussed and what innovation means in terms of education and priority policy in innovation and sustainability.

In order for education systems to nurture a culture of innovation and sustainability in the school staff room, this research suggests that far greater clarity and classification methods need to be employed to define exactly what the subject matter and learner attributes in schools are meant to address compared to the wider world demands upon it (Annison, 1999; Australian Government, 2008; Australian Government Department Education Science Training, 2003a; Australian Science Technology and Engineering Council, 1996; Commonwealth Government of Australia, 2001; Cutler & Company, 2008; Innovation Summit Implementation Group, 2000; Kurzweil, 1999, 2001; Organisation for Economic Co-Operation and Development; 2007c; Spoehr, Barnett, Moloy, Vas Dev & Hordacre, 2010).
2.1.3.3 Innovation and the knowledge economy in purpose and context

Innovation has become a significant driver in the economy. In a technological context this includes often subtle but significant variations from the way things are laid out, the materials used, to more overt transformations such as new ideas – all of which are validated in the market. With increasing demands to compete in innovation, the role of new knowledge or access to new techniques, materials and manufacturing in tools and equipment are dimensions of technology that have well asserted themselves as core areas of knowledge demand — to this extent, innovation is not only driven by creativity but also new knowledge and devices. The drive to innovate in technology to maintain a market presence is very strong in the modern exchange of capital, and has been well assisted by knowledge as a market advantage. The knowledge and innovation economy is significant to this study because Food Technology is not immune to these drivers of change. The following sections explore the historical backdrop for the term ‘the knowledge economy’, innovation as a phenomena, and education’s role in supplying suitably able students who can meet the demands of entrepreneurial behaviour required from the workforce.

According to Tzeng, (2009, p. 373) innovation should not be compared with the technologically minded inventor consumed with over-preparation and special technical knowledge. Instead, innovation involves “exploit and market opportunities”. Drucker (1994) declared the dynamic phenomena and the psychology of entrepreneurial activity is instrumental to economic change and growth because the entrepreneur upsets and disorganises; a type of “creative destruction” (Schumpeter, 1994, p. 83), where old approaches are replaced with new ways of doing things while transforming economic
structure from within. Nevertheless, cognitive ability was viewed as historically contingent and facilitated through tacit knowledge and applied through diverse processes in an open-ended environment. Networking and sharing of knowledge was also integral to the entrepreneurial process (Endres & Woods, 2010). These key ideas are synonymous with entrepreneurial activity and offer key foundational ideas from an historical perspective for understanding the combinations of knowledge required for entrepreneurial behaviour, core to the study of Design and Technology in schools.

The historical beginnings for the term ‘innovation’ emerged through economic trend observations by Tarde, a judge, who coined this as ‘imitation’ (Rogers, 2003). According to Rogers, imitation implies that “an individual learns about innovation by copying someone else’s adoption of the innovation, implying that diffusion is a social process of interpersonal communication networks” (p. 41). What interested Tarde was the adoption or rejection of an innovation—why only a few may obtain acceptance, why many others may not—and the connection between the interactions of individuals and groups in society (Tarde, 1903). He also speculated that humans learn from each other similar to that of animal sociologies, which many other educational theories are drawn from.

The individual develops an astonishing initiative. Comparing to ants—how do labourers and migrations of ant swarms begin? How do they build bridges? Is it through a common, instinctive, and spontaneous impulse, which starts from all the associates at the same time, and under pressure of outward circumstances, which are experiences simultaneously by all? On the contrary, a single ant begins by leaving the others and undertaking the work; then it strikes its neighbours with its antennae to summon their aid and the contagion of imitation does the rest (Tarde, 1903, p. 4).

Rogers (2003) concluded Tarde’s imitation philosophy was a ‘group think’ tenet and developed as a “crucial outcome variable in diffusion research” considered to be a “basic and fundamental explanation of human behavioural change” (p. 41). However, his work was not considered credible until some forty years later when the theory was empirically
tested. This is an interesting aspect from the literature that furthers the field of study in that it presents a two-pronged argument for education:

1) The importance of empirical research in education, particularly technology and Food Technology education to further the field of study that extend to real world contexts; and

2) The ability to nurture self-directed work teams as a form of productivity in the classroom through social networks.

A core cultural driver of innovation is Trist’s Socio-Technical Systems Theory. He postulated successful systems were largely determined through “joint optimisation” as a motivational factor and thus important for an individual to function as an agent of social change (Passmore & Khalsa, 1993, p. 555)

These key historical concepts are important to the literature as it directly relates to the critical nature between the interaction of technical and social systems that impact on the success of an innovation; core areas of study in the junior and senior Design and Technology syllabi (New South Wales Board of Studies, 2003; New South Wales Board of Studies, 2009). More importantly, self-directed teams play a critical role in providing a platform for students to develop more autonomy, confidence and a new habit of mind toward innovation capacity building for emerging world concerns, particularly in food technology research. While the knowledge era did not really change much on the economic plateau (i.e., remained tool dependent), this era introduced the idea that knowledge was valued and should be recorded. Information became important for people to share knowledge quickly and this is now an expectation in daily business routine.

Innovation is thus the result of numerous interactions by a community of actors and institutions, which together form what are termed national innovation systems. Increasingly, these innovation systems are
extending beyond national boundaries to become international. Essentially, they consist of the flows and relationships, which exist among industry, government and academia in the development of science and technology. The interactions within this system influence the innovative performance of firms and economies. Of key importance is the “knowledge distribution power” of the system, or its capability to ensure timely access by innovators to the relevant stocks of knowledge (Organisation for Economic Co-operation and Development, 1996, p. 16).

According to Drucker (1994), one of the core misunderstandings around innovation is that it is considered a theory. Drucker argued innovation is not a theory but rather a structure because people work within various structures (1994, p. 206). His institutional thinking analysed management processes used in organisations and the dynamics between creating and maintaining relationships. Managers, in Drucker’s view, were the innovators responsible for ensuring organisational objectives were achieved and where they were both game designer and game participant. Thus he coined the term ‘knowledge worker’ as he believed the knowledge worker positions a product rather than invents a product. What Drucker did was conceive a new socio-political reality where science was no longer the foundation of the economy (although still a key force), but instead knowledge became the new driver for contemporary society.

What matters is that knowledge has become the central “factor of production” in an advanced, developed economy. Economists still tend to classify the “knowledge industries” as “services”. As such, they contrast them with the “primary” industries-agriculture, mining, forestry, and fishing, which make available to man products of nature-and with the “secondary” industries-that is manufacturing. But knowledge has actually become the “primary” industry, the industry that supplies to the economy the essential and central resource of production. The economic history of the last hundred years in the advanced and developed countries could be called “from agriculture to knowledge”. Where the farmer was the backbone of any economy a century or two ago-not only in numbers of people employed, but in importance and value of what he produced-knowledge is now the main cost, the main investment, and the main product of the advanced economy and the livelihood of the largest group in the population (Drucker, 1992, p. 264).

Drucker’s work is an important aspect in relation to technology education because the development of knowledge is a fundamental intellectual and theoretical attribute required
for adaptive and flexible contexts post school. Daly & Walsh (2010) add that society, markets, customers and technology are in a constant state of flux therefore it is critical that teachers foster attributes in students where students can identify in themselves weaknesses and build strengths in commitment, persistence and diligence in order to cope with future social, economic and environmental changes. Key to this is to nurture in students the ability to be adaptable and flexible to change, and to have the capacity to be imaginative and creative, self-motivated and organised, and to feel comfortable in risk taking, team work and decision making processes (DEST, 2003; Moyle, 2010).

Innovation is considered successful when an individual or social system changes to accommodate or adopt an innovation. These changes could be intended or unintended, desirable or undesirable, direct or indirect, stable, dynamic or unstable. Rogers (2003) suggests an innovation is not considered so if the idea, product or system has not been adopted successfully in the market place. Conventional views of innovation seem to stop short at the prototype or commercialisation stage while the critical stage of diffusion is often ignored. Rogers adds that this aspect has received very little study in design and technology education. His work is particularly relevant to guide teachers’ understanding of the nature and process of innovation and thus promote best practice in teaching students how to think and act differently as a schema to capture new ideas and translate them into value for other people. In this view innovation and the development of enterprising behaviour or entrepreneurship in students should form dominant thinking, modelling and practice that in turn may shape a perspective of how teaching is viewed.

One aspect that needs to be clear is the purpose for the study of food technology. The economic driver is the purpose and historically, policy was to keep the family fed—and in many ways that resonates today—but the difference today is more about serving the big mass supply sector in an increasingly scarce supply of resources and changing climate.
This demands more and more food innovations and sustainable food processes and production outcomes. The next section maps priority innovation policies established to help meet change successfully and the role education may play in these initiatives.

**Priority innovation policies in purpose and context**

One of the core aspects of this research is to understand innovation policy and to identify the different purpose drivers and affect this may have on society. In the attempt to study the underlying patterns in the literature around the concepts of technology, broad themes will always occur and that there is some sort of policy or purpose in every technological context. This section contributes to the need for teaching innovation policy in schools as a way to understand how big picture ideas gain prominence on government agendas and as a way to energise a link between innovation diffusion and policy making processes. The engagement in policy networks would also equip students with a broad level of readiness for life and work beyond schooling.

Directions for a sustainable economy in Australia have been evident since the establishment of national innovation systems during the 1980’s. The aim was to promote commercialisation of research, scientific discovery and technological advances and development across various institutions that comprised of business firms, universities, research institutions, private and public institutions (Annison, 1999; Cutler & Company, 2008). In 1991, the Australian government encouraged research collaborations between the public sector research institutions by establishing the Co-operative Research Centre programs (CRC). The aim was to focus research and development efforts on progress towards utilisation and commercialisation to benefit the end-user engaged in the project. In spite of this, Australia, compared to other OECD countries, ranked 16th overall in 1994-95. Annison (1999, p. 72) highlighted the adoption in new technologies as a ‘prime
determinant of productivity’ that led to a push for the Australian government to improve funding for research and development. Universities and organisations such as the CSIRO were prioritised as the food processing industry was technology intensive across the biological and material sciences (ibid).

In 1996, the Federal Government endorsed the Australian Science, Technology and Engineering Council (ASTEC) foresight review that identified essential priorities for the national interest of technology and science. The study underpinned foresight as an essential dimension for thinking which attempted to capture the dynamics of change. The underlying thrust was a need for Australians to develop holistic understanding and skills in science and technology and to be both ‘sustainability’ and ‘futures oriented’ in the interest of national development (ASTEC, 1996). The review recommended technacy to be incorporated into primary and secondary school teaching practice as a framework to foster innovation capacity building among students (ibid, p.6). The review also noted the importance of technacy as a framework for achieving science and technology national goals as priority action 8 for the Commonwealth Government.

ASTEC considers it essential to integrate the role of S&T in economic, social and environmental decision-making into the 21st century. This will require a greater community understanding of the role of S&T, which will in turn require improved S&T skills learned from childhood. ‘Technacy’, the technological equivalent of literacy and numeracy, is defined as competence in S&T problem solving that develops the ability to integrate the human, social, environmental and technical aspects of technological issues or initiatives (ibid, p. 8).

Although its functions were taken over by the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), the long term directions changed considerably due to a change of government in 1997 (Smith, 2006). The Australian Business Foundation (ABF), for example, was established as an independent body funded by the business sector with the aim to identify and meet the knowledge-based economy demands. The foundation declared a significant change was required in the existing innovation policy if Australia
was to capture opportunities in the global market. The foundation concluded that the dominance of the ‘science, technology and research push’ needed to be secondary to the ‘demand pull’ of business engagement with markets and customers. This led to a study, *The High Road or the Low Road? Alternatives for Australia’s Future*, in 2003 that aimed to identify knowledge and relationships as an integral component in helping to build learning and problem solving as intangible assets for competitiveness and profitability. This dimension of innovation would ensure that knowledge would not be “restricted to scientific discovery or to the products of research and development” (Kennedy, pp. 24, 2005). Earlier national reports echo the need to embrace new ways of doing business beyond the traditional domain. For example, the Innovation Summit Implementation Group in 2000 presented an 18-month analysis report *Innovation: Unlocking the Future* of the strengths and weaknesses of Australia’s capacity for innovation to the Australian government and the Business Council of Australia. The thrust of the report signified the importance of creating an “ideas culture” that was not afraid of taking risks, and where experimenting and enterprise would be rewarded (Innovation Summit Implementation Group, 2000, p.15).

We are in the midst of a revolution from which a new order is emerging. The solutions of past decades will not suffice in the new knowledge age. Intangible assets—our human and intellectual capacity—are outstripping traditional assets—land, labour and capital—as the drivers of growth. If we are to take the high road, a road of high growth based on the value of our intellectual capital, we need to stimulate, nurture and reward creativity and entrepreneurship (Department of Education, Training and Youth Affairs, DETYA, 2000, p. 8).

This report played a central role in the development of *Backing Australia’s Ability: An Innovation Action Plan for the Future*. In this plan the major initiative aimed to foster innovation through scientific, mathematical and technological skills in government schools in those states where the Enrolment Benchmark Adjustment (EBA) was triggered (Commonwealth Government of Australia, 2001, p. 5). Although the council recognised
previous achievements of Australia’s capabilities for building a healthy economy, the
document acknowledged that Australia was still sitting at a crossroad. In support of
Backing Australia’s Ability, the Federal Government presented a national priority report in
2003: Australia’s Teachers: Australia’s Future, Advancing Innovation, Science,
Technology and Mathematics. The basis of this agenda for action stated the need to
develop a culture of continuous innovation through design, technology and science
education. This capacity to be innovative was noted as an essential ingredient to support
research and development and where education and industry are intimately related in
achieving this goal but are often treated as separate ‘engines’ (DEST, 2003, p.5).

Australia needs to be at the forefront of these developments, to create
and extend innovation capability, and to bring the education system to
the centre of the knowledge revolution. The knowledge economy
depends on continuous innovation, to develop new products and
processes and to adapt to established ways of doing things. This
imposes quite diverse demands, from extending the frontiers of science
to educating for the many different kinds and levels of skill and
capability needed by the nation’s workforce. Innovation and a capacity
for innovation call for many varied talents. As the Australian Council of
Deans of Education says, these are for personal growth and citizenship
as well as employment. Scientific and mathematical knowledge, and
technological capability, are essential for the knowledge economy and
to achieve high levels of innovation (ibid, p.1).

Other national and international documents present the case to meet change successfully
and sustainably. For example, Frontier Technologies for Building and Transforming
Australian Industries (DEST, 2003) stated Australia’s national research priority number 5
was the need to be at the cutting edge of international developments in order to maintain
argued of the new focus needed in business innovation, while the OECD (2007c) cited the
need for science, technology and innovation indicators to respond in a rapidly changing
world. The 2008 document, Venturousaustralia: Building Strength in Innovation,
acknowledged Australian productivity growth slowed considerably from 2002 and that
funding innovation in science and technology was no longer enough. Skills in
collaborating and sharing of ideas to meet customer and community needs required strengthening between industry and education as a whole system from early childhood to tertiary and higher education in order to meet critical challenges ahead.

High quality human capital is critical to innovation. Equipping our people with the skills to innovate is essential, not only for the generation and application of new knowledge, but also to use and adapt the knowledge produced elsewhere. Using the admittedly imperfect yardstick of the level of funds dedicated to public education, it is also an area in which our commitment has been waning, even absolutely as a share of our own economy, but far more emphatically so compared with other countries. For most of the post-war period Australia was one of the leading OECD countries in its commitment to education, as measured by the share of public expenditure. By 2003, however, Australian public expenditure on education had dipped to 4.7 percent of GDP, below the OECD average of 5 percent (Australian Government, 2008, p. 11).

Further to the Australian government’s push for innovation as a national priority, the National Innovation Council was nominated to support the private sector for innovation in resource industries—space and astronomy; finance and risk management—while the Enterprise Connect Program was established to strengthen business innovation services. Priority areas identified in the public sector included: agriculture and food security; climate change mitigation and adaptation; population health; solutions in tropical environments and applications to utilise broadband infrastructure (Australian Government, 2008), with the latter still trying to find traction today. In 2009, the Commonwealth of Australia Department of Innovation Industry Science and Research (DIISR) projected a ten-year horizon agenda to improve the national innovation system. This aimed to focus the production, diffusion and application of new knowledge between researchers and industry as these were seen as long-term weaknesses in business innovation. Key to this was harnessing the creativity of our people. By 2010, Spoehr, Barnett, Moloy, Vas Dev & Hordacre (2010) presented a report to the Department of Further Education, Employment, Science and Technology, Connecting ideas: Collaborative innovation for a complex world. This document advocated a multidisciplinary collaboration between science, technology,
engineering and mathematics (STEM) and the humanities and social science (HASS) disciplines to tackle complex social and environmental problems. The focus on STEM raises an interesting scenario for inclusion in the emerging National Curriculum as a compelling case to find some policy traction in the educational arena.

In an educational context, the Australian Government’s Department Education Science & Training (DEST, 2003) sought teachers to model and nurture students in an environment that stimulated multifaceted skills commensurate with innovation capacity building. These critical elements for determining economic outcomes involved shared norms, values and understandings, and social success through human capital (knowledge, capability and learning).

Schools and teachers are pivotal to the development of the knowledge and competencies of individuals [often referred to as human capital]; and the shared norms, values and understandings that underpin cooperative endeavour in broader society [often referred to as social capital]. In short, individuals with the array of skills constituting a well-developed capacity for innovation — At all levels, our society will require creative individuals to be able to communicate well, think originally and critically, adapt to change, work cooperatively, remain motivated when faced with difficult circumstances, who connect with both people and ideas and are capable of finding solutions to problems as they occur (DEST, 2003, p. 5).

These desirable skills included the ability to identify and exploit cross-knowledge or cross-domain patterns (also known as transfer and abstraction skills); apply ideas into unfamiliar settings; break boundaries; problem solve; and conceptualise as a part of a team. Core attributes to these include remaining focused and determined during difficult circumstances (DEST, 2003; Fee & Seemann, 2002; Kenway, Bullen, Fahey, & Robb, 2006).

We are in the midst of a revolution from which a new order is emerging. The solutions of past decades will not suffice in the new knowledge age. Intangible assets—our human and intellectual capacity—are outstripping traditional assets—land, labour and capital—as the drivers of growth. If we are to take the high road, a road of high growth based on the value of our intellectual capital, we need to
stimulate, nurture and reward creativity and entrepreneurship (DEST, 2000, p. 8).

However the literature suggests there is a significant proportion of teachers in the technology field who appear to have struggled and resisted, (more than one would expect), cultural and technological change with qualifications that fall short of the standards that the profession itself has begun to set for teaching technology in secondary schools (DEST, 2003). This thesis sought to analyse and understand whether there is a capacity for NSW schools to deliver on the above agenda given the historical difficulties within the state’s system to embrace new pedagogy in the field of technology education and associated teacher capital. For example, an area of study that has been poorly integrated into Australian curriculum for the past ten years concerns Futures Studies. Slaughter (2000) cites that it is largely due to poor leadership and scholarship by principals, executive staff and curriculum writers. However, a new paradigm shift is evident in comparison to previous syllabus offerings. The next section explores Slaughter’s work and the impact his work has had at a national curriculum level in Australia.

Foresight Studies

In developing a national foresight strategy for Australia, Slaughter’s vision in 1999 was to change current practice of past values and to create preferred futures. The thrust of the idea was to enable the projection of a rationale for sustainable futures pathways that provided a clear understanding of the past, why it was that way, and the relationship with politics and economic drivers as change agents over time. A case in point would be the nature of the ‘industrial era’ and the reasons why it no longer fits in with today’s 21st century economic climate, given the last century has been spent perfecting 19th century schooling. Social construction of time is the key factor to Foresight Studies through back casting “what has gone before” in order to design a preferred future that is sustainable
(Slaughter, 1999, pp. 151). This is not to be confused with “predicting” the future but more about imagining the future, the types of technology that future society will need, the social changes that the new technology may cause and the possible nature of that future technology.

Slaughter emphasised a necessary shift was long overdue; away from a “materialistic, short-term, high-impact, rapid growth outlook to one that is post-materialist, long term and low impact” (Slaughter, 1999, pp. 3, 151). Yet one of the core problems has been education’s overly cautious and slow to static policy change. The paradox remains that foresight is highly relevant to education as it is related to social learning through understanding concepts. Core to foresight, the principles are to improve long-term decision-making and guide technology choices, thus developing layers of capability in students that nurture a much-needed steering capacity to design sustainable future landscapes.

Education is one of the great futures-shaping institutions of our society, and the futures now in prospect are exceptionally challenging. Put simply, moving blindly into the 21st century is a certain recipe for disaster; there is simply too much that can go wrong. Proactive leadership is, therefore, likely to have characteristics that uses futures concepts and literature; deploys futures tools and methods; exploits information systems; and develops an informed view of ‘the larger picture’ (Slaughter, 1999 p. 88).

Although little has been published since Slaughter’s literary works more than ten years after being written, his work brings a theme and dimension to this thesis because Foresight Studies is counterpart to innovation and thus highly relevant to technology education as a way to provide the tools for understanding and action needed to address a profoundly changing world. Our children, our students, are the inheritors of past decisions and stakeholders in their future world — they need to be able to re-connect with nature and make discerning decisions that are sustainable for years to come (Slaughter, 2000).
At the time of finalising the writing for this thesis, the Australian national curriculum in Technologies has included a filtering of Foresight Studies concepts in the initial shaping document for the curriculum writers. Although the Technologies learning area originally contained three strands: 1) Design and Technologies, 2) Digital Technologies and 3) Preferred Futures, the final document has used Preferred Futures as an overarching theme throughout the two strands: 1) Design and Technologies and 2) Digital Technologies.

The overarching idea of creating preferred futures bridges the subjects and strands and allows students to engage purposefully in this endeavour. It is reflected in each of the subjects to ensure a futures-oriented approach to Technologies learning. It frames the development of concepts in the Knowledge and understanding strand, supports key aspects of the Processes and production skills strand, and contributes to developing students’ capacity to be active, innovative and informed citizens (Australian Curriculum Assessment and Reporting Authority, 2012, p.10).

It is argued a stand-alone Preferred Futures strand would strengthen the emerging syllabus and thus place it at a world-class level as a syllabus for the 21st century. It would also be reasonable to suggest that this would provide a foundation under which Food Technology could be better optimised as an area of study to be exposed to and learn about priority food policy. While it is difficult to locate a best fit for the Food Technology subject in this current shaping phase, the States and Territories may continue to offer additional technologies-based learning opportunities.

2.1.3.4 Sustainability in purpose and context

Food Technology education as a sustainable enterprise

A part of the motivation for embarking on this research is linked to the researcher’s previous teaching experience in schools. It is debatable whether the existing practice for the teaching of Food Technology in many NSW schools is sustainable for the 21st century given the dominant line for consumption based, end-user cooking skills. The reasons for this approach have been well justified for teaching students important life skills in cooking
healthy foods. Yet society requires more innovators in the agri-food chain for our future, yet the same subject area in school systems can often be presented in a much more conservative form (Annison, 1999; Australian Bureau Agricultural and Resource Economics, 2008; Australian Bureau of Statistics, 2010; Australian Food & Grocery Council, 2009, 2010; Australian Government AusAID, 2010). The role Food Technology education can play in helping prepare society to develop a culture of innovation and sustainability around food practice is crucial and deserves a rethink in light of the emerging National Curriculum. Students studying the subject need to be better educated in the plethora of elements and complexities of the food supply chain and associated food carbon footprint. The challenge for curriculum writers for secondary studies in Food Technology is to determine a syllabi focus and structure using the same logic as national innovation systems.

Food Technology involves technological activity in nearly everything undertaken or made in the subject area, therefore it is critical students are exposed to the ‘whole menu’ of Food Technology as a sustainable food system, one that is recognised by students as being able to maintain the health of people and is not wasteful of top soil, water, fossil fuels and other finite resources. Where the combination of increasing human population and resource use is costly in terms of global biodiversity, it cannot be understated that food supply chains for future generations remain a significant issue in relation to sustainability in the supply of nutritious foods, marketing, storage and transport (Australian Conservation Foundation, 2008; Strange & Bayley, 2008, p. 26; World Vision, 2009). This research presents a case for the critical need for curriculum to present a coherent picture of sustainability in terms of food and to integrate innovative and sustainability concepts.

The ultimate challenge for education, environmental or otherwise, is to prepare people with the skills and knowledge needed to identify and shape the quality of the world we share with others—human and nonhuman; in a multicultural and political world, this means education
for cultural competence and political participation. Both in and outside of schools, there is currently too much complacency toward problematizing the homogenizing standard practices of general education and too much caution around taking the political stands that will be needed to reform it (Gruenewald, 2004, p. 2).

Since the Brundtland Commission Report in 1987 *Our Common Future* (World Commission on Environment and Development, 1987) presented the principles of sustainability framed through social, economic and environment indicators, the complex and interconnected nature of global problems has resulted in widely differing views by those with diverse political and personal commitments. Essentially, sustainability is “an on-going learning process” (Tilbury & Cooke, 2005, p. 3), “a process of conscious collective evolution and not a matter of a few quick fixes and business as usual or pursuit of a single social value; it is continuous principled vigilance” (Harrison cited in Elshof, 2005, p. 1). Sustainability cannot be taught as isolated or stand alone content. It involves a systems thinking approach that “involves people, tools and the consumed environment, driven by purpose and contextual factors” (Seemann, 2009, p. 118). Schools as stakeholders ought be a fundamental springboard for innovation capacity building and sustainable development, but to a large extent there has been a disconnect between the teaching research nexus with regard to collaborative industry partnerships (OECD, 2010b; Strange & Bayley, 2008). Based on the literature thus far, the school institution itself needs to accommodate a fundamental shift in the current paradigm of conventional practice for what it means when we say sustainability and innovative food futures in Food Technology education. Crib, (2010) points to real world issues of rising population and food demand, water, land, soil nutrient and energy source and scarcity as crisis areas due to ‘ecological overshoot’. Our carbon footprint through technological activity contributes to the state of play now (Stern, 2007).

August 22, 2012, was Earth Overshoot Day, marking the date when humanity has exhausted nature’s budget for the year. We are now operating in overdraft. For the rest of the year, we will maintain our
ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere (Global Footprint Network, 2012, para 1).

At the time of writing this thesis, the Australian Bureau of Statistics (2010) highlighted that Australia accounts for 1.5% global greenhouse emissions, the CO2 emissions for this country are nearly twice the OECD average and more than four times the world average [per person per capita]. Additionally, the relationship between technological activity and our carbon footprint is an area of ‘drought’ knowledge in the curriculum. While some of these aspects may be touched upon in the classroom through general discussion, it is not a requirement to teach this from a syllabus perspective (personal communication O’Connor, June 20, 2006; personal communication Percival, June 16, 2006). Yet problem solving in ‘our own backyard’ would yield a fruitful exercise toward developing students as talented and innovative thinkers and doers who could be a benefit to Australia and the planet.

Promoting a ‘new habit of mind’ that amalgamates purpose and contextual factors and associated tools, knowledge and material understandings for design solutions may yield a more progressive learning approach rather than focus on a ‘making and eating-need’ alone (Newcombe & Seemann, 2008). At what scale and context should the subject be taught? That is, to feed a family or to feed a nation? The literature indicates that some aspects of teaching appear to have reached their plateau, or state of peak knowledge, struggling if not resisting reform and replacement with new discipline ideas and methods (DEST, 2003). The amalgamation of fluid intelligence and the capacity to unlearn long-standing cognitive structures are important attributes to be able thrive with new knowledge (Belsky, 1990). It makes sense that the study of Food Technology should educate our students well into the next decade for real world contexts, and that students develop suitable attributes to embrace change, who are able to differentiate human technological practice and possess a capacity for
making long term sustainable decisions (International Institute for Sustainable Development, 2002; OECD, 2007a-a; Pearce, 2006).

The next section briefly explores the state of food supply in Australia and relevant food policies are discussed. A central tenet to this thesis maintains that priority food policies are relevant to student learning as a way to amalgamate a new dimension to the study of Food Technology and opens up a key aspect for shaping debate about the nature of food security problems and consequent societal issues.

**Priority food policies in purpose and context**

Priority policies for food systems at national and international levels should be a much-needed boost as world food supplies have reached serious levels of concern while national economies, such as Australia, have been experiencing a decline in primary industries since 2001 (Australian Bureau of Agricultural and Resource Economics, 2010; Australian Government (2010); Australian Government AusAID, (2010); Food and Agriculture Organisation of the United Nations, 2010a, 2010b). The three largest exporting states in Australia have been Victoria (31%), New South Wales (23%) and Queensland (20%) during 2009-2010. Figure 3 shows food exports grew and peaked up until 2001 and again — but not as high—in 2009, but overall food imports show a steady and continuous rise compared to food exports (Figures 3 and 4). The graph suggests that Australia’s food supply is in a fragile state, not only because exports are in decline, dropping significantly in 2010 causing financial concern, but more importantly that ingredient and food imports put our nation at food security risk on social and industry levels. It is predicted that this export pattern will continue to decline by 9-10 per cent by 2030, and 13-19 per cent by 2050 (Australian Bureau of Agricultural and Resource Economics cited in Australian Government, 2010, p. 2; Australian Food & Grocery Council, 2010, pp. 6, 10, 18; Australian Government, 2010, pp. 2-4).
The burgeoning drought conditions and the effect this has had on water supply has proven to be a crucial demise in our food supply systems (Australian Bureau of Statistics, 2010; Australian Bureau Agricultural and Resource Economics, 2008; Australian Food & Grocery Council, 2010; Carberry, 2010; CSIRO and Bureau of Meteorology, 2007; Hafi, Thorpe, & Foster, 2009). It is predicted that climate change will continue to be a significant driver for change in the production of food, and governments worldwide are being asked to manage farming practice to a more sustainable level and to achieve outcomes that are more socially acceptable (Larson, Ryan & Abraham, 2008). The purpose for Australia’s agricultural policy framework is to build a more sustainable system that incorporates key aspects for human, technical, material and ecological elements:

1) Market access [membership of World Trade Organisation and development of free trade agreements]; 2) Income variability and tax averaging [saving when harvest is good for low times when not thereby reducing income distortions]; 3) R&D [address underinvestment by private sector. This focuses on emissions and carbon footprint]; 4) Water markets [assigning water rights for efficiencies over time]; and 5) Risk management and adjustment policies [drought, climate change, biosecurity, natural disaster relief] (Hogan, & Morris, 2010, p.13).
Various reform policies have been designed to ensure a long-term sustainable outcome for Australia’s food growing industry. A number of reports under these policies highlight the water security issues and the need to adapt to the ongoing drought conditions. For example the 2004 *National Water Initiative* (2004) by COAG was designed to complement the 1994 initiative (Commonwealth of Australia, 2007), while *The Water Act* in 2007 aimed to manage the Murray-Darling Basin as a long-term national interest. Additionally, the Australian Government’s *Water for the Future Program* aimed to assist farmers to transition toward more sustainable water diversion limits under the Murray-Darling basin plan (Australian Bureau of Agricultural and Resource Economics (ABARE), 2010). The New South Wales government for instance unveiled the *Research for Action-Productivity and Food Security* in 2009 to tackle the growing problem of food security. The Minister for Primary Industries highlighted the NSW agricultural industry alone is worth $7.7 billion that employs around 73,400 people (New South Wales Government, 2009). It was declared that there was an urgent need to increase agricultural productivity for the following reasons:

Food security is one of the biggest issues facing our planet. Worldwide food shortages, rising food prices, the global financial crisis, a changing climate, other environmental issues, skill shortages and increasing biosecurity threats are issues affecting food security right now … Providing food has been a challenge for society for centuries, but the primary industries sector is experiencing rapid change … Global output must increase by 75 per cent by the year 2025, and it must have doubled by 2050 to meet expected demand (Macdonald cited in NSW Government, 2009).

Although the plan was targeted more for drought conditions, the emphasis on establishing effective trade relationships were seen as crucial to ensure continued access and self reliance in food production. In addition, the *Paddock to Plate: Policy propositions for sustaining food & farming systems* suggested priority areas for the Victorian food and farming systems to involve better use of energy and water and nutrients plus substantially reduce greenhouse gas emissions and minimise waste and pollution. The need to reduce
the reliance on food imports was a key goal to ensure future food security could be met (Campbell, 2009).

The food system is a heavy component of the human environmental footprint on the planet. If current trends in human population and consumption patterns continue, the world will need to produce about twice as much food by 2050, in a rapidly changing climate, with declining production of oil and rising prices for energy, water, fertilisers, and soon, carbon. The era of abundant, cheap fossil fuels is over. Traditional avenues of expanding production though clearing, irrigating and cultivating more land are narrowing, and food is now competing with energy for land and water resources (ibid, p.iv).

In particular, Queensland’s food processing industry (the largest in Australia) is quite vulnerable due to the reliance on importing ingredients. The move away from natural resources to value-added products also include “changing eating patterns, the effects of climate change and rising costs of labour and energy, all of which are compounded by low cost competition from international companies” (Queensland Government, 2010, p. 7). While economic, social and technological challenges concerning land availability and usage, production processes and market and labour skills share a common thread with other areas of production and consumption, agriculture in the primary industries is highly dependant on the state of the environment and its natural capital (Australian Government, 2010, p. 2).

Food is essential, and will inevitably have an embedded environmental impact through its reliance on land, water and energy. However, a sustainable food system would have to be one that continues to supply the nutritional demands of the population without diminishing the stock of natural capital on which it lies. That will only be possible if there is relevant knowledge on the life-cycle impacts of the food system and if investment and policy is framed with sufficient foresight regarding environmental, technological and social trends (Larson, et al., 2008, p. 5).

In times of rapid technological change, there is little doubt we can no longer assume Earth is a limitless supply of materials and a “waste disposal sink” (Royal Society of Chemistry, 2010). Work is evolving in the ‘farm to plate’ aspects for both domestic and international contexts by way of energy use, soil management and food miles. The collaborating and
sharing of ideas to manage sustainability issues demonstrate a significant contribution in
the shifting balance of agricultural markets and the push to meet customer and community
needs. This state of play on the planet and the environmental condition that has unfolded
now affects the security of water supply, food and energy and as such demands an
environmental conscience from Food Technology teachers and students.

It is timely to pause and consider the core research question that lies at the heart of this
thesis: To what extent is Food Technology in schooling well placed to meet emerging
policy and economic demand for food innovation expertise as innovative and sustainability
informed Food Technologists? How well Food Technology in schooling offers a pathway
into an undergraduate degree in Food Technology is explored in the following section.

This historical review compares the beginnings of food education and educational reform
across three Western countries — Britain, America and Australia. These countries were
chosen specifically because traditionally they display a political and educational alliance,
particularly between Britain and Australia due to their Commonwealth allegiance.
America has been included because Australia has had close political links since WWII.

This section also explores the beginnings of the Australian food industry and the
subsequent need for food technology degrees in higher education.

2.1.4 Historical Overview

Contextualizing the history of technology education is critical for
teacher preparation and graduate programs. Otherwise, the field risks a
continued decline in its capacity to think critically, research, and teach
about the relationships between technology and society (Pannabecker,
2004, p.77).

A key feature of Technacy Genre Theory is that it can identify time as an important aspect
in historical events through purpose and context factors. The aim of this section sought to
identify technology and food education through a chronology of milestone events from the
17th century to the 21st century. Technology education has been included because historically the subject ‘manual training’ when first brought into schools aimed to provide a trained workforce in the trades and combat social issues for males. On the other hand the purpose of female education was societal rather than vocational (although perception would gradually change to vocational) with training in housework, cooking and sewing. Historically there have always been very precise societal and economic contexts that are seen as essentially unchanging or taking many years to change. This is significant in understanding the nature of societal and economic demands in a contemporary context where shifts are now constant. Added to this, government policy is a driver that determines the purpose of curriculum content — how a subject should be framed, how it is practiced and how it benefits society. This section connects relevant information from the literature that reveals there has not been strong evidence to suggest that contemporary food technology education has evolved at the same pace compared to the outside world from school.

2.1.4.1 European and British education in purpose and context

Manual training and food education

Craft and technical training was introduced into English grammar schools during the 1880’s largely due to their economic competition with France. Chafy (1997) highlights that the French were instrumental in building upon Francis Bacon’s concepts in advancing civilisation through technological progress to achieve a more advanced state of being. Thus science, technology and arts were embedded in their curriculum. The School of Chalons (1807-1830) was very unusual in their approach at the time, catering for the training of boys and young men in “forging, foundry, carpentry and lathe turning” in workshops by tradespeople, while “teachers tutored the theory of the arts consisting of
geometry, drawing and wash drawings of machines” (Pannabecker, 2004, pp. 222, 227). This was a school that offered an alternative to the traditional apprenticeship and one that had “contentious relationships with external markets” and thus inextricably linked to national political change (Pannabecker, 2004, p.224).

Conversely, Sloyd education, an English term for the Nordic name (slöjd) was practiced in Finland and Sweden. This was a cultural activity involving a variety of designed handcrafts in woodwork and metalwork, electrical and mechanical engineering, sewing, weaving, and various decorative textile techniques (Alamaki, 1999; Sjoberg, 2009).

Historically, Sloyd education was a fundamental economic driver during the Agrarian Era, but during the industrial revolution around 1860, VanIngen (2003) highlights that there was a shift away from the cottage industry structure to a more commercially efficient one as a measure of economic survival. This resulted in Uno Cygneaus (a Lutheran priest) launching slöjd schools to supply the growing labour force. His interest in developing “the eye, the sense of form and general dexterity” (Hansen, 2008, pp. 5, 6) was derivative of Froebel and Pestalozzi’s work which advocated craft as an important part of a well-rounded education toward the development of mental and physical competencies, values and ethics. Regular teachers were the instructors, rather than skilled craftsmen, and subsequently design became an integral component to the practical process. An instructor from one of the schools, Otto Salomon later started a Sloyd-based teacher preparation school that soon found traction as an elite international learning centre (VanIngen, 2003).

According to Johansson (1907), Sloyd essentially drew on the emotion of the craft as a wholesome enterprise in a setting where students learnt through constructing artifacts.

Historically the French artisans influenced the British school system in manual arts training that fundamentally sought to educate young men for an industry job. However, the British translation of ‘manual training’ developed along a different pathway due to
their differing industry needs compared to the French. The purpose attached to manual and technical education in England was heavily influenced by the Industrial Revolution. A series of Acts were introduced in an attempt to improve their manufacturing industry and to educate the growing problem of child labour in the lower classes. The British House of Commons, who had concluded their manufacturing industry was inferior to France, passed the first successful Factory Act in 1830 which also determined the working age of children. The Industrial Schools Act of 1866 followed in an attempt to create job pathways for boys who were committed by the Liverpool magistrate’s warrant for detention (Bremner, 1897; Macdonald, 1970). Normal Day Schools were established in 1836 with the Normal School of Design following in 1837. This school was set up by the Board of Trade for vocational training to improve the country’s export dollars. The Science and Art Department was later formed under the Board of Trade in 1837, with the New Education program founded at South Kensington due to the demand required for more skilled artisans, and thus established manual work in elementary schools (Macdonald, 1970).

Sloyd education was augmented in schools but was modified from the Nääs School of Slöjd approach. A series of events produced two different Sloyd genre – the Danish and Russian system where “work exercises only, and paid little or no regard to the usefulness of the articles made”, whereas the Swedish Sloyd made “complete and useful things” (ibid 1891, p. 224). However, there were points of contention that required ratification to the program:

1) The Swedish Sloyd approach had no fixed discipline or teacher support documents, but instead important aims of Sloyd were presented in a simple list.

2) There were historical and cultural differences between England and Europe with regard to tool and materials choice. This resulted in modifications of the Swedish Sloyd system to suit the English student’s needs and character.
Thus a hybrid (quasi pre-trade training) English Sloyd model was born. Ricks, a distinguished teacher, disagreed with this approach declaring the educational purpose for manual training was that intellectual and moral results were placed before mechanical skill:

If I may venture on a definition, I should say that Manual Training is a special training of the senses of sight, touch, and muscular perception by means of various occupations; and it is a training of these faculties not so much for their own sake, though that is important, as it is a training of the mind. While the eye is being trained to accuracy and the hand to dexterity and manipulative skills, the mind is being trained to observation, attention, comparison, reflection, and judgement (Ricks cited in Barter, 1892, p. ix).

Although there were contradictions between Ricks and another distinguished teacher, Barter, what emerged from the original educational intent of Sloyd education as shaping the child in a well-rounded education turned to that of pre-trade drill and practice.

In comparison to a boy’s vocational pathway, a girl’s vocation in life was to become suitably qualified in domestic duties, primarily as a good homemaker, but also as a career person if an occupation was sought. Rutland (2005) cites the earliest record of cookery schools in London dates back to 1740, available for upper class women even though traces of Chantry Schools had been operating since the Conquest and continued until 1645 (Bremner, 1897). These schools were founded by the Church, which provided literacy and craft training skills for future employment for lower class girls. Henry VIII effectively removed this form of education for women during the Reformation period, as he believed women were not entitled to a career beyond wifehood and motherhood. The general opinion was that it was unnecessary to educate women because it was seen as detrimental to cultivate their intelligence. According to Bremner, middle and upper class women’s education after this period and up until the mid 1800’s was received at home and involved home duties and craftwork.
The introduction of Cookery into British elementary schools was essentially influenced from the need for females to cook for those men who were recruited into the army for the Crimean War (Akiyama, 2008). Although Charity Schools were introduced in the latter part of the 18th century to provide training in crafts for upper class females, it was not until free Elementary Schools were introduced in 1891 that lower and middle class females were able to attend a formalised school environment. The reason was predominately economic that involved training for vocational education in low paid employment (Rutland, 2005). Bremner (1897, p. 47) outlines a typical curriculum in a girls school involved “reading, writing, arithmetic and two class subjects (English, geography, history, sewing, or singing), and one specific subject (algebra, chemistry, domestic economy, French, or cookery)” Dril and practice were perceived essential to meet industry demand and as such girls schools could not receive a grant from the Education Department in London to study any subject unless cookery and sewing was undertaken.

In spite of the push for more academic rigor in female education, Churchwomen schoolteachers working under the Board in London were influential in retaining cooking and sewing (Dyhouse, 1977). Additionally, education was male dominated and accordingly reflected the societal and cultural values of the time — to improve basic living and hygiene standards and develop an understanding of nutrition and the management of family resources. Roach (1991, p. 238) described this as “the special function of women in the making of the home and the preservation of the social side of society”. Walsh’s 1856 Manual of Domestic Economy and Beeton’s 1861 Book of Household Management were instrumental in informing the content of courses prior to the development of a more formalised curriculum in the early 1900’s. The manuals included a strong focus in domestic ‘science’ but also included advice on fashion, home furnishing, child-care, animal husbandry, poisons, and management of servants, religion, and recipes. These were
essentially accounting and accountability guides for running middle to upper class Victorian households, largely constructed around the prevailing notions of female domesticity and reinforced private patriarchy (Walker, 1998). The strong emphasis on science in the home was originally derived from Accum’s 1821 *Culinary Chemistry* through essays suggesting cooks were already chemists:

> The art of preparing good and wholesome food is, undoubtedly, a branch of chemistry; the kitchen is a chemical laboratory. However, with concerns emerging over the safety of science and the contamination of foodstuffs during the nineteenth century, this similarity drawn between cookery and chemistry was not necessarily a comfortable or comforting one (Accum, 1821, p. iv).

Bernays (1853) adopted similar rhetoric in his *Household Chemistry* book by inviting readers to engage with the Chemistry of the Breakfast-Table (Bernays, 1853). This is an interesting aspect from the literature as it demonstrates an early interest in food science consistent with scientific enterprise during this period. Although food science as a form of chemistry found its way into a domestic setting it was gradually overshadowed with the focus on food processing over the following decades. This was largely due to the strong vocational driver to train females as domestic servants or as capable housewives.

Due to the societal expectations many middle and upper class females had few opportunities other than to train as a domestic servant or gain an apprenticeship in dressmaking, millinery or mantua making (tailoring), with the lower class relegated to factory work in textile mills or agricultural work. Rendall (1990, p. 56) lists the main occupation in 1811 for females of all ages in Great Britain constituted domestic services: 1,756. Rutland (2005) points out this need to produce a skilled workforce increased vocational training in state education. The National School of Cookery was founded at South Kensington in 1873 as a measure to ensure teachers (as well as students) were trained in cookery, laundry, dress cutting, hygiene and housewifery. The London Technical Board established in 1893 set in place trade schools for males and females
operating under the name of Polytechnic Institutes by 1894 and which provided a scholarship pathway from elementary and secondary schooling. The National School of Cookery later moved to Battersea Polytechnic Institute in 1889 with a name change to the School of Domestic Economy (Bremner, 1897). The evolution of manual and domestic training in British education up to the 18th century set in place a similar system and pattern that would be followed for many centuries — offering a curriculum with a vocational preference toward the trades for the less academically able or food taught as a Domestic Science drawing on nutrition and science through selective grammar schools for the academically able. However, a shift in paradigm occurred during the late 1900’s where food science appeared to lose its importance and was replaced with a stronger emphasis on nutrition and cooking processes (Rutland, 2005).

The low status theme for food technology in secondary curriculum continued to the post-war era of 1945. While education changed little up to this point in time, social, economic and political changes reflected forces of scientific and technological change after the 1940’s, requiring a shift in job skill demand and knowledge. The next section brings to light some of the difficulties in making curriculum change.

Contemporary curriculum

Technology education and food education

During the 1970’s, Project Technology and Design and Craft Education explored new design approaches using existing traditional crafts. The aim was to open up opportunities and to expand technology education into computer and information technology areas. Electronic music and photography are examples of the frontier technologies during this period (Eggleston, 2001). Craft, Design and Technology (CDT) curriculum emerged as woodwork, metalwork, technical drawing and plastics. This resulted in the Design Council
endorsing design education as an essential strand of learning in the curriculum by 1980. The development of design education and the 1980 Design Council report was based on research and development in Design Education, sponsored by the Design Education Unit at the Royal College of Art during the 1970’s to the mid 1980’s. During this period, vocational education received ministerial backing in forging a stronger relationship between secondary schools' curricula to the world of work — Home Economics was included under this initiative. Schools received funding for equipment, materials and staffing under the Technical and Vocational Education Initiative (TVEI) scheme but there were problems articulating students’ work experience with the content of their schools’ formal curriculum due to a fundamental weakness in that the program did not have a clear purpose (Eggleston, 2001; Hudson (1996). Eggleston (2001) points out much of the work to bring Design and Technology to life in the curriculum was not without underlying issues. The perceived view was that technical skilling through TVEI was more appropriate for students but was accompanied by widespread concern by teachers and the community that the subject was not achievable for students. It is interesting that although a TVEI program was in place to fill the ‘skilling’ needs for industry, Design and Technology was perceived as ‘some sort of threat to industry’.

The Education Reform Act in 1988 produced a National Curriculum with a Design and Technology a foundation subject in the curriculum for children aged 5-16 by 1990. This course of instruction integrated craft/design/technology areas with art, design, business studies, home economics and information technology (Eggleston, 2001; McDonald & Gibson, 1995). At this point in time there appeared to be a sense of crisis about the subject and that food teachers in particular were considered politically weak and resistant to change. The national Association for Teachers of Home Economics argued the subject accommodated the changing political landscape:
...provided the best opportunities for the future of food teaching in schools as it was an approach that accommodated changing attitudes and values concerned with gender, status and its association with the less able (Rutland, 2009, p. 5).

According to Rutland it was clear the subject needed to find a new direction and subsequently the name changed to Food Technology. The subject moved from its traditional domestic focus to more of an industry focus. In spite of this, teacher perceptions documented in Belby’s 2005 dissertation cited a heavy emphasis on skilling and tooling practice at the expense of applying nutritional knowledge. On the other hand the role of food science offered a central position where students could benefit from being exposed to in order to understand personal health (Rutland, 2005).

In 1995 stakeholders were required to justify the actual benefit of studying Design and Technology as the subject did not attract high attaining students (Eggleston, 2001; McGimpsey, 2011; Miller, 2011). The problem here was that the vision of the subject was not well communicated as having a solid framework and did not lend itself to schools’ teaching pedagogy and physical resources. At a local level the view changed about the purpose of D&T, which conflicted with the original intent at a policy level in that the subject “incorporated the bodies of knowledge of several other subjects” (Miller, 2011, p. 17).

Many argued in the attempt to “slim down” the curriculum the syllabus lost its capacity to incorporate problem solving given the narrow theme to ‘design and make’ (Miller, 2011). By 2001, proponents of D&T questioned Design & Technology as an integrated subject across English, Maths, Science and ICT as the creative and enterprising aspects would be at risk of being ignored thus narrowing the scope of Design & Technology (Barlex, 2002). Further to this, science and technology were highlighted as separate domains of knowledge and practice and where technology would be at risk of being subsumed into the science
discipline. Barlex debated the positioning of the subject in that, educators in other disciplines misunderstood Design and Technology. He added with regard to integrating Science and Design & Technology, “when the two communities of teachers can begin to understand each other, maybe then there will be a useful relationship in a cross-curriculum format” (ibid, pp. 5, 6)

In essence science is concerned with the production of tested knowledge that can be used to explain and make predictions about behaviour of the natural world. Scientists construct concepts and models, which may be linked to form theories explaining at a deep, level the way the universe works. Technology is concerned to transform this and other sorts of knowledge into techniques and artefacts for which there is human demand. The report states quite clearly that it is important to realise that technology is more than the artefacts and techniques it produces involving in addition socio-technical systems of manufacture and socio-technic systems of use (Barlex, 2002, p. 5).

The positioning of the subject in 2004 lost its compulsory status at the Key 4 level but remained compulsory for Key 3 level. Another revision in 2007 was really an amendment of the 2004 syllabus but a significant change included the addition of diploma qualifications in engineering; society, health and development; construction and the built environment; IT; and creative media. The diplomas “combine practical skill development and theoretical understanding, covering sector and general learning in applied contexts” (Qualifications and Curriculum Authority, 2007b, p. 8). The Design and Technology programme retained the cross-curricula opportunities but also offered opportunities outside school, particularly for food technology and science:

Planning and carrying out practical and investigative activities both individually and in groups” (science). The study of food could be linked with human processes in science and healthy lifestyles in personnel wellbeing (Qualifications and Curriculum Authority, 2007a, p. 57).

Although on paper much of the rationale for the programme read well in theory, it was argued some sections were contradictory as some traditional methods prevailed. For example, the skewed lean toward cooking and nutrition overshadowed food science, which
remained restricted to sensory properties only. However, advocates such as Rutland (2009) continued to publish the importance of connecting science and food technology through cross curriculum collaboration.

Pupils require a scientific and technical understanding of foods so that they can make sound design decisions. The term ‘the science of food and cooking’ appears appropriate for this area of the food technology curriculum. Other areas of design and technology have been modernised though the use of ‘digital technology. However, this is not appropriate when designing food products. In food technology, the emphasis is on experimentation and combining a range of ingredients to get a desired effect. The modernisation of food technology would be through an understanding and application of the underlying science and the impact of new technological developments. The impact of a modern food technology curriculum would be to strengthen the links with science, especially chemistry (ibid, p. 375).

The state of play for Design &Technology in the national curriculum in Britain today appears to have lost its momentum. The strong historical relationship with craft has created a push/pull tension between educator stakeholders and policy makers who aspire to build a pool of engineers rather than more designers. The push for a STEM based curriculum is obvious:

D&T is said to have an uncomfortable status because it lacks a disciplinary home as either an art or a science; because of its exclusion from articulations of strategic policy priority through either STEM or the more recent E-Bac; and because of its loss of compulsory status KS4…Prominent commentators have observed that while the UK has lots of designers, it has too few engineers; and furthermore that our engineers do not understand design. DT in practice has failed to answer these compelling arguments for making it central to STEM (McGimpsey, 2011; Miller, 2011, p. 21).

The science of food appears to hold little value in the curriculum. This poses a worrying scenario for the need to develop a culture of innovative and creative and sustainable food practice given the global demands of food security and the need to supply students into the food technology and science industries.

As the subjects of manual training and domestic economy evolved over time and across western societies, so did variations of name with each country advocating a different
purpose as it pertained to human capital, economy and policy. Yet personal ideologies often drove the final content outcome (Stage & Vincenti, 1997, p. 5). The following section explores the beginnings of technology curriculum in America that differentiates from their British counterpart. Initially, the Chalons School model of manual training was used but the shift toward science and engineering collectively produced a STEM curriculum that has now generated interest from Britain.

2.1.4.2 American education in purpose and context

Manual training and food education

Manual training schools were established throughout America up until 1886. Cultural differences and character of the technical instruction were clearly defined between towns and cities both nationally and internationally. For example, American manual training was more advanced in material use and resembled a vocational level quality, similar to the Chalons School in France although the first year consisted of practiced techniques rather than object completion. Where America was more formal and whole class instruction, England provided individual tuition and produced thrifty household utensils limited to woodwork, similar to that of Swedish Sloyd instruction and tool approach (Woodward, 1887).

Bennett observed in 1907 two manual training paradigms emerging: one of vocational demands and one of cultural virtue (Appendix 4). Thus manual training evolved into manual arts, and industrial arts became the antithesis. The industrial education movement in schools was revealing itself as “cultural by virtue of being highly vocational” while manual arts was “work that is cultural first, then vocational” (ibid, 1907, p. 190). According to Foster (1997), Bennett advised the manual arts profession to adjust their courses to meet vocational demands. Simultaneously, influential federal leaders were in
the midst of drafting a legislation that would become the Smith-Hughes Act, a massive push for funding vocational programs in public schools that occurred in 1917. Many were convinced the role of the school was to provide a well-rounded liberal education and that specialist training should be relegated to technical agencies or colleges. As a result, The Progressive Education Association was formed in 1918, which promoted child centred teaching and learning approaches.

As made clear by Bonser and Mossman (1923), industrial arts was a product of the progressive movement. Even without the benefit of much hindsight, educational historians of the 1920’s declared industrial arts—social industrial arts—to be an old idea, one which had been popular in Europe in the sixteenth, seventeenth, and eighteenth centuries. In other words, it had been a recurring trend in Western Education for hundreds of years, and a trend which had never taken hold. As aforementioned, despite what many of its historians have suggested, industrial arts was not an outgrowth of manual training, which at the time was at the height of its popularity. Quite to the contrary, it was a reaction against manual training. This relationship provides a microcosm of the interaction between the two major rationales for public education in the first quarter of the twentieth century: the social-efficiency and student-centred theories (Foster, 1997, para 4).

It was argued that Industrial Arts sought to educate children’s understanding of their technological world, of the home and of the commercial industry – it was a unifying, all encompassing force rather than a discrete discipline – manual training placed more emphasis on the object and tool. Although Bonser and Mossman advocated a socio-industrial framework as a theoretical basis for technology education it was never implemented on a large scale (Clark, 1989; Davis, 1988; Foster, 1994; 1995). This situation resonates with the issues facing stakeholders today concerning the confused state of technology education and the push for vocational education and training in Australia. Female education duly followed that of Britain but quickly divided into two disciplines: Domestic Arts and Domestic Science. Similar to Britain, there were no syllabi prior to the 1800’s to explain the content and nature of food courses, but rather manuals and books written for homeowners, young ladies or students from middle and upper class families,
and teachers. The most popular American books and manuals for domestic management and housekeeping were published by, Donovan (1830), Beecher (1865) and Campbell (1897). These provide the only clue to the content and the degree to which Domestic Arts reflected the societal and cultural values of the time — the reinforcement of women to duties relating to the home and family. However, due to the evolving nature of the educational institutions and multiple subject offerings open to females from 1784, science and mathematic curricula studies were increasingly offered to those from the middle and upper class (Tolley, 2003). This did not occur without educators debating women’s proper role in society and any inquiry into the schooling of females must therefore also explore this larger political, social, and economic context (ibid). Although female interest in the sciences was very high conceptually, science education was deemed unimportant by Virginia’s Bedford Female Academy in 1837 because females were deemed not suitable to be doctors, engineers or navigators but rather they should understand much more of cookery than of chemistry (Tolley, 2003).

On the other hand educational reformers such as Beecher and Phelps pushed for a distinctly female science curriculum centred on applications of science to the household. A new term, Domestic Science, was used to differentiate the specific application of scientific principles to domestic activities under the term Domestic Arts. Although Beecher’s *A treatise on domestic economy, for the use of young ladies at home and at school* advanced the rhetoric of domestic science, and the most accepted first body of work, Tolley points out the most widely used text between 1810 to 1830 although not unique in the coverage of scientific topics to the traditionalist view of domestic science, was written by Marcet in 1805. However, Phelps’s *Chemistry for Beginners*, published in 1834 included practical examples using chemistry to make ice cream. Other

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3 Conversations on Chemistry; Conversations on Natural Philosophy; Conversations on Vegetable Philosophy
applications included charcoal as an antiseptic, the uses of muriatic acid, and the effects of gypsum as a fertiliser. Parker’s *Juvenile Philosophy: or Philosophy in Familiar Conversations* demonstrated the principles of science about “rain, colour, vision, the eye, light, fire, heat and wind” (Tolley, p. 58). This was a different approach to domestic science as it was not domestic in content but rather in its context. Both Marcet and Phelps are important to the literature as the principles of science aimed to develop knowledge in food and ingredients rather than the application of science to the activities of the household alone.

Richards pushed the original notion for the subject as a natural science and felt it should share equality in the curriculum with other sciences in female schools. Yet Domestic Economy needed to distinguish itself from the art of cooking food to understanding the science of food. The problem from the outset with this concept was the need to link the areas of study into one subject (the home) rather than what appeared as a myriad of isolated facts. Often teacher preference turned to cooking instead.

If however the lessons on domestic economy are delayed until the pupils are in the high school, the first endeavour must be to bring into line whatever of science training they have had; their interest must be awakened in the application of the laws they have learnt in their school laboratories. For them the school kitchen is only another kind of chemical laboratory. In case of a possibility of a three years course in the high school the third year should give an opportunity for the class to combine the foods prepared by the other classes into a suitable dinner with the refinements of service, and with careful calculations as to cost of materials and of preparation. So little attention has been paid to the science of cooking there is a wide field here for original work (Richards, 1889a, p. 15).

Trade schools in cookery were established in 1866, with little attention paid to the science of cooking. The School of Domestic Economy was established as an educational subject in 1874, made possible through the First Morrill Act of 1862. This act was a catalyst in furthering agricultural and mechanical colleges and opened up the connection between farming produce, and food handling and storage, with key aspects focusing on the
economical use of products from the farm, dairy and garden (Stage & Vincenti, 1997). Mary Abel in particular believed food involved a ‘whole system’. Her book, *Care of Food in the Home*, published in 1909, introduced the importance of growing or purchasing and storage of food, preparation and cooking (Abel, 1909). This is an important aspect in the literature as it demonstrates a holistic approach to food from a ‘paddock to plate’ perspective, a topical area of research that has had resurgence in today’s economy as an attempt to promote locally grown food, thereby reducing carbon emissions through food mileage.

Richards, on the other hand, developed branches of study under Household Administration involving laboratory work, such as Sanitary Science and Sanitary Chemistry. Materials and equipment used in the home context were studied; for example, the making of a fire where scientific knowledge was required to understand the principles of oxygen as fuel and heat transfer from kindle to coal, whilst maintaining the correct temperature to simmer water in order to steam a pudding. The chemical examination of air, and water, of milk and butter followed, with the chemistry of cooking and food nutrition, care and hygiene of the household evolving as core areas of study (Ravenhill, 1911; Richards, 1889a; 1889b; Talmage, 1893). Richards believed the environment could be controlled and was a strong advocate for improving the living conditions of human beings. Her work built upon Eugenics (the improvement of race through hereditary means), and developed Euthenics as a means to “improve race through the environment”. By this it was understood that pure food and safe water provided the right living conditions for a “clean and disease-free atmosphere in which to work and live, proper shelter, and the adjustment of work, rest, and amusement” (Richards, 1912, pp. vii, viii, x). Richards sought for Domestic Science to be available at a university level and pushed for the subject to be reclassified from the
umbrella term ‘Household Arts’ because it implied cooking and sewing and therefore tied to manual training.

Given the period in time, it made sense home-making could be worked out on engineering principles. The mechanical setting of life is [sic] become an important factor, and this new impulse which is showing itself so clearly today for the modified construction and operation of the family home is the final crown or seal of the conquest of the last stronghold of conservatism, the home-keeper. Tomorrow, if not today, the woman who is to be really mistress of her house must be an engineer, so far as to be able to understand the use of machines and to believe what she is told. Your ham-and-eggs woman was of the old type, now gone by in the fight for the right to think (Richards, 1912, p. 153).

However, not all stakeholders in female education agreed. Although Richards had been an advocate for food science and the importance for women to become more knowledgeable about products and the connection between home-making and engineering since 1889, Tolley (2003) concedes that the subject failed to have continued interest due to the push from proponents for domestic duties in cooking and housework. Field and Connell (2004) add that this was directly linked to a lack of scholars in the sciences writing textbooks for Domestic Science and a lack of experienced academics to design curriculum. Various semantics also proved to be a problem as public opinion was that the subject ought constitute cooking. As a result, Home Economics officially emerged in name by the early 1900’s but with mixed feelings from various stakeholders who debated the subject as either science laboratory orientated or domestic duties orientated (Stage & Vincenti, 1997; Weigley, 1974). The Lake Placid conference on Home Economics in 1902 proved to be a catalyst for the direction in which Home Economics would be positioned. It was at this conference that Melvil Dewey determined the library decimal classification amidst a divided view for the future of Home Economics.

Under Melvil Dewey’s leadership, a session was devoted to the library classification of home economics literature. Agreement was reached to catalogue future home economics publications as a section of sociology under the number 339. While pauperism was already assigned that
number no problem was anticipated, for pauperism resulted from the lack of attention to home economics! (Weigley, 1974, p. 85).

Richards advocated the subject to be taught as a branch of science under ‘Useful Arts’ (600) where Domestic Economy was positioned and thus catalogue Home Economics under 640. Many disagreed, pointing out “the difficulty of having pupils make a practical application of principles” opposed to the actual accomplishment of something “tangible such as food preparation had greater appeal to the general public” (Weigley, 1974, p. 86). As a result a two-pronged definition emerged:

Home economics in its most comprehensive sense is the study of the laws, conditions, principles, and ideals which are concerned on the one hand with man’s immediate physical environment and on the other with his nature as a social being, and is the study of the relation between these two factors (Fields & Connel, 2004, p. 245-246).

Although Home Economics was agreed as a general term by the association charged with the development of the subject, Domestic Economy was decided for junior school and Domestic Science for high schools was used where food science methods could be applied in a laboratory setting (Campbell, 1913). Up to the 1930’s food science experiments and chemistry as an applied science were fundamental aspects in the curriculum, however, the content to be studied was left to the instructor’s discretion and as a result the practice of food science became less important by the 1940’s. The strong vocational push from the George-Barden Act in 1946 was also a contributing factor (University of Michigan, 2010). By the 1950’s the curricular landscape in America moved toward a new emphasis on science education due to industrial expansion: “Nationally there was a shift from endeavoring to educate a well-rounded generalist to a technically adept specialist” (ibid, p. 362). This was largely due to the new vocational training that emerged in science and technology under the National Defense Act in 1958, emphasising math, science and foreign language. Post-war food innovations began to emerge after 1945 that provided an increased need to understand the palatability of food and how to prepare, store and cook
pre-cooked, frozen or dehydrated foods. By the 1950’s there was a move toward nutritional science, textile science and understanding how to use new tools and equipment in the household. In many ways Home Economics aligned study content with technological innovations as they pertained to the home but more in a technical and aesthetic way rather than a scientific way (Cornell University Mann Library, 2003; Elias, 2011). Marthers (2011) highlights women’s increased higher education study, and employment opportunities during the 1960’s overshadowed the need for a domestic arena in which women had a niche influence at the turn of the 19th century. This is an interesting facet from the literature as it reflected the necessity for education to keep pace with the changing needs of the economy and social transformation — key elements of this thesis. Literature in the next section explores the continued academic debate in technology education and the associated policy ‘shifts and turns’. The evolution of Home Economics is identified and the position the subject has adapted in today’s global economic context.

**Contemporary curriculum**

*Technology education and food education*

Well before the education reform movement of the 1980’s, there were a series of significant organisations that emerged. The American Industrial Arts Association (AIAA) was formed in 1939, which later became the National Education Association (NEA) in 1942. The Industrial Arts Curriculum Project in 1965 was an important milestone for knowledge building as a structure for a practical based curriculum. Throughout the 1960’s and 1970’s industrial arts remained conservative and culturally starved with no resources or systemic interest to evolve the subject. Values, beliefs and traditions were entrenched in an old paradigm of manual training from the 1900’s (Clark, 1989; Davis, 1988; Foster, 1994). Lewis (1991) highlighted that the legacy was set in 1914 and continued to keep the subject ‘frozen in time’ through constrained curricula boundaries:
For pedagogical purposes, the materials of significance in the industries are (1) foods, (2) textiles, (3) woods, (4) metals, and (5) clays and other allied materials. The next step is to single out the dominant processes in the successive stages of production, manufacture and distribution (p. 623).

By 1981, the Jackson Mill Project undertook a comprehensive study to identify a central focus for Industrial Arts. The aim was to move industrial arts away from the pre-vocational position to one of studying technology and human productivity in various industry contexts (De Miranda & Folkstead, 2009; Foster, 1994; Williams, 1996; Zuga, 1989).

A newly formed International Technology Education Association (ITEA) created the first set of Standards for Industrial Arts Programs in 1981, later revised in 1985 as Standards for Technology Education. This represented a theoretical shift and despite these efforts to establish technology education as essential to the curriculum, administrators, curriculum developers and teachers did not consider the subject as core (Clark, 1989). It was around this time Carl Perkins lobbied for vocational training in schools. The Vocational Education Act in 1984 was legislated to improve existing vocational programs and to better serve the needs for disadvantaged and disabled students. The Vocational and Applied Technology Education Act in 1990 and the School-Work Opportunities Act in 1994 followed (Davis, 1988; Foster, 1997). This vocational push created conflict in technology education and subsequently the “industrial arts paradigm as originally intended morphed into a paradigm of vocational education” (Clark, 1989, para 7) and by mid-1990 caused a split between state and federal values in education. As a result, a new movement emerged called STEM (Science, Technology, Engineering and Mathematics). Like science, the relationship between engineering and technology historically echoed similar but different values and approaches, but the justification was determined through teaching engineering drawing and design in technology education.
Research undertaken by Wicklein in 1993 revealed an overall non-unified problem with design approaches, paradigms and content in the curriculum. This was associated with the knowledge base of the teachers indicating present and future concern and the strong voice for an integrated curriculum with other disciplines (ibid). Conversely, Hook (2001, p. 31) declared technology education had long suffered an identity crisis given various name changes associated with the “varied, complex, and non-descript methods of new and old practices” and differing from school to school. This situation was evident in Australia as well due to a lack of a coherent framework or guiding principles. Between 1996-1999 a structure was formulated pertaining to significant and timeless universals for technological literacy such as knowledge, processes and contexts. While these standards were quite detailed they failed to make coherent what is common among all technological practice.

During 2001 and 2004 ITEA conducted two surveys to identify public perceptions of technological literacy: *How Americans Think About Technology*. The majority believed technology and science were ‘one and the same’ and had curriculum importance but the nature of what technological literacy meant was isolated to computers only (Rose, Gallup, Dugger, & Starkweather, 2004).

In 2007, there were numerous labels for the study of technology, but the ‘umbrella’ term Technology Education was the most popular (Dugger, 2007). Overall, the subject appears divided and confused. Where technology educators find it difficult to distinguish between science and technology, and while the public still view technology as using computers, the ‘manufacturing’ focus under industrial arts continue to dominate the curriculum. Regardless of this, Dugger has long been an advocator to integrate engineering as the main vehicle for technology education. His reasoning is based on the growing need for engineers to be grown in the US rather than China or India. Additionally, the uptake of this idea and the whole STEM integration process is problematic given the historical nature
of technology education and literature thus far. Dugger’s vision is extremely relevant to the literature as technology is revealed as a blurred subject of confusion as much as is the need to promote engineering studies in the curriculum. Yet there are flaws in emphasising one discipline over another, as the discipline processes differ between engineering, science and technology. The literature suggests that making change in curriculum will always be fraught with tension and Home Economics was no exception.

Under the umbrella term of Home Economics, a proposed name change to Human Ecology during the 1960’s aimed to set a new direction as a field of study. A review of the subject revealed stakeholders as having differing perceptions and perceived the subject as:

1. A single field with a broad general perspective and a number of sub-specialties;
2. A unified field with sub-specialties embedded in the home and family; and
3. A collection of disciplines with no unifying theme or "anchor" Baugher, Anderson, Green, Shane, Miles, & Nickols (2010, para 5).

At best, the analysis, dialogue and partial agreement in 1961 resulted in a ‘best fit’ body of knowledge (Baugher et al, 2010). However, the name change to Human Ecology was met with much distain from opposing stakeholders and as a result the name and purpose of Home Economics was retained in the latter part of the 1960’s (Connell, 1960). An overriding theme that emerged from the literature connects with the idea for the need of a unifying frame that could ‘make sense’ of technological activity across different contexts. During the 1970’s the Home Economics Association commissioned a study of the public perceptions of the subject with the aim to develop goals for a public relations campaign. Public opinion revealed widely differing perceptions and as a result five priorities were identified in 1975 that resulted in a shift away from home and family to emphasise the ecosystem, humans and their environment: 1) futuristic thinking, 2) public policy
formation, 3) creative adaptation to uncertainty and change, 4) redistribution of resources, and 5) interrelatedness of the professional and the paraprofessional (Roofe, n.d.). This was referred to as Critical Science but educator stakeholders did not accept the subject and the labelling and content of Home Economics remained (Connell, 1960).

By the 1980’s the profession was challenged to defend its rationale and by 1994 approval was given for a name change from Home Economics to Family and Consumer Sciences due to the continued lack of identity and stereotyping the name Home Economics unintentionally conveyed (ibid). This was not without much examination of the mission, breadth and scope of the subject. The result identified a broader definition that included “business, industry, government and social service” as well as the home, but essentially the underlying thrust of the subject supports social justice, consumer rights and family life (Roofe, n.d.). Pearson (2008) states that the subject today is offered as an elective subject in junior and senior schooling, often under the labelling of Home Economics. A typical subject range in the junior years (6-8) extends from food and consumer science (impact of science and technology on food composition; food safety and analysing living environments) to human development and interpersonal skills. In years 9-10 culinary skilling is favoured although food science principles, nutrition and economics of food, business and mathematics are also offered. Yet career pathway options in the senior years (11-12) offer a humanities theme rather than a science and technology theme — Early Childhood, fashion design, interior design, hospitality and tourism. This discussion permits some insightful understanding and reflective thinking given the strong theme for culinary vocational skilling rather than the study in food science and technology arguably recognised as “the timeliest and the most relevant professions of our time” (Jideani, & Jideani, 2010, p. 2486).
Australia’s historical educational legacy contributes to this patterned discourse to that of America and Britain. The next section briefly maps across significant periods from the early penal settlement to the present day, while discussion around the higher education system aims to put into perspective the current wave in educational change.

2.1.4.3 Australian education in purpose and context

**Manual training and food education**

Australia, being a Crown Colony of Great Britain, duly followed the British education system but under a different societal structure. The eastern coastline of Australia was claimed by the British in 1770 and settled over subsequent years through penal transportation. The NSW penal settlement was not a haven for the rehabilitation of felons, but a prison as their punishment. Social and moral needs were important if not an urgent need to train up the ‘rising generation’ to be better behaved than their parents. During the pioneer period of 1793, public schools were funded by the British government under Westminster – a parliament that at the close of the 18th century had not yet directed itself to the education of its own children. The supervision of the schools was overseen by the Anglican Church until 1810 (Department of Education, 1980; Peacock, 1982). The growing need to address homeless children resulted in establishing male and female orphan schools in 1802 to teach basic literacy and religious instruction — females were taught needlework and spinning and some writing skills. Ragged schools followed in 1878 to cater for children from very poor families similar to those established in Britain (New South Wales State Government, 2011a).

By 1880 the council was dissolved through the Public Education Act with responsibilities transferred to the Minister for Public Education (New South Wales State Government (2011b). This effectively severed the ties between Church and State, and in doing so
established a basic framework for education in NSW. Australia became a federation in 1901 and formed the Commonwealth Government with five states and two territories eventually structured.

The early 1880’s witnessed a growing demand for a more structured education system which led to the expansion of grammar schools and colleges for boys and girls, both offering academic studies in Reading, Writing, Arithmetic, Grammar, Geography, Scripture, French, Latin, Euclid (Geometry) and Algebra (Department of Education, 1980; Peacock, 1982). Many academics heralded the importance of intellectual growth for boys but others cited the need to incorporate manual training for students as a trade to prepare them more for employment beyond the school gate. Industrial schools were established in 1865 in the form of technical education in mechanical arts, with Sydney Technical College established in 1880 (New South Wales Department of Technical and Further Education (1983). Manual skilling did not emerge into the New South Wales public school system until 1914 due to the 1890 Depression (New South Wales State Government, 2011a). This was also compounded with the view that manual training courses were deemed vocationally orientated by scholars and as such perceived as low in socio-economic status in the curriculum. The English version of Sloyd work was introduced for boys at Kings Grammar School that aimed to develop a male’s manual dexterity and hand-eye coordination.

Our present aim is a social one; we wish to train our pupil in all points. So that when he leaves his school-world he will not feel the real one strange and distant, but a natural continuation of his former experiences. To do this we must make our schools bridge the gap between the previous home-life and the pupil’s future life work. If we are going to equip him thus, it will not suffice that the training afforded be merely intellectual, for he needs many other things besides a fine intellect; his physical and moral faculties are equally important; without these attributes the mighty intellect is like a rudderless bark. Not one of these faculties can be neglected without injuring the others (Martin, 1910, p. 355).
Although Martin (1910, p. 356) documented that Sloyd education was not to be taught as a trade but instead in “a disciplinary manner as part of a primary education”, manual skilling was interpreted as pre-trade training. The vocational push corresponded to the economic demand for a trained workforce that continued well into the 1970’s. Williams (2005) declared this focus on skill development was still evident in junior schooling even though the demand for a skilled workforce has changed in nature. The focus on early skill development remained because “the expectation became obvious that the technical curriculum was part of the solution to poor academic performance” (p. 1). This expectation was echoed in food education for females — culinary skilling and household management dominated due to the societal demands at the time.

For the majority of girls the home will be their sphere of future usefulness. Traditional usage of management of home affairs has ruled in the past; the aim is now to bring intelligence to the task. The laws of health afford quite as useful an increase of thought as the laws of motion; the kitchen as an experimental laboratory may be of intense interest and the possession of the purse an opportunity for skill and forethought as necessary for the happiness of the home as the plans of a treasurer for a nation (Annual Report of the Ministers 1905 cited in Peacock, 1982).

Food Technology as an area of study in NSW secondary schooling can be traced back to Domestic Economy in Great Britain. However it was Caroline Chisholm’s pioneering work that set the foundations of Domestic Economy classes for girls. In contrast to the needs of Britain and America, the Australian penal colony of the 1700’s was a period that was economically and politically unstable with associated problems of a scattered population (NSW at the time included Queensland and Victoria) and one that was divided on religious lines.

Chisholm’s British influence upon her arrival in Australia in 1838 initially aimed to meet the needs of a colony that required not only social and moral enlightenment, but knowledge, values and attitudes pertaining to health, hygiene and wellbeing (Suttor, 1882).
Chisholm brought with her the experience from running the Female School of Industry in India. The school in India was established for the daughters of European soldiers, where they were taught reading, writing and arithmetic as well as needlework, cooking and housekeeping. Instead of opening up a similar school in NSW, Chisholm educated underprivileged children and females within the colony in “personal and clothing care, human relationships, the wise management of resources, planning and wisdom in the management and preparation of food” (Peacock, 1982, p. 18). This became her life long work and epitomised Home Economics concepts “centred in the promotion of the individual, family and well-being” (ibid). Peacock adds Chisholm is often referred to as the first Home Economist in the early settlement of Australia.

The first Government Cookery School was established in 1883 at Macquarie Street, Sydney, while the Fort Street Model School was set up in 1840 as a training centre for teachers in Needlework. This provided a job pathway in Needlework tuition for wives of existing schoolteachers and opened up opportunities to teach cooking skills. The Public Instruction Report in 1849 added Domestic Economy to training programs for all women later formalised under the 1880 Public Instruction Act, which included the introduction of cooking lessons (Peacock, 1982), with Fort Street Model School opened in 1890.

The structural design of a ‘Syllabus’ emerged by 1912 and the general re-structure of schooling followed accordingly. There were three courses of instruction, each designed to furnish a preparation for a definite type of vocation by means of:

1) A junior technical course leading to industrial pursuits

2) A commercial course preparing for business careers

3) A domestic course qualifying for home management (Domestic Science)
Superior Schools were re-organised into vocational schools, Technical or Trade schools were established for boys and Domestic Science schools accommodated girls training. Secondary education for girls was formally introduced in 1913 as Domestic Superior Public Schools. A typical course of instruction in Domestic Science can be located in Appendix 5. The aim of the course was to provide girls an interest in the practical art of living gathered around the management of the home, the treatment of young children, the care of the sick, the economical use of household material, the preparation of food, the question of clothing, the expenditure of household income, the cultivation of grace and beauty in the home and its surroundings. The preamble for subsequent syllabi in Domestic Science and Home Economics up to the 1940’s continued to reflect home care and management tasks as a continuing influence for women to be trained in home duties.

These schools, as the name implies, aim at giving the girl that instruction which will enable her to fill more adequately the position she now occupies as daughter in the family, at directing her attention to and equipping her for the responsibilities of a home maker, and at the same time, giving her some preparation for the occupation she is likely to enter on leaving school (Minister for Education, 1930, p. 123).

Nevertheless, a new frontier in syllabus direction emerged during the 1950’s. The Home Economics syllabus was designed to integrate with other curriculum areas, particularly science yet reflected dual values: science vs. home-wifery and cookery (Appendix 5). This was a radical departure from previous syllabi that retained a strong British domestic flavour — women’s work in the home such as business methods and learning the management of money. This syllabus reflected social and policy change during the aftermath of World War II. There was a strong sense of self-expression, creativity, resourcefulness and frontiers in science and philosophy (Department of Education, 1980; Peacock, 1982). But the syllabus also contained conflicting aims, in that it sought to “train the pupil for future home making” (New South Wales Department of Education, 1952, p. 1) by way of housewifery and domestic hygiene subjects (New South Wales Department of
Education, 1952, p. 1). By trying to keep in step with the changing needs of society while acknowledging the need to retain the family unit, the syllabus created a dual dilemma for teacher interpretation. As a result, and perhaps due to the sheer magnitude of the syllabus intent, the internal tensions of the times led to the science strand being shelved by many teachers.

During the 1960’s a name change to Human Ecology was pushed in America but Domestic Science prevailed by name in Australia. Syllabus offerings demonstrated a renewed interest in the science of food (Connell, 1960). The economic and social shift during this period bore the catalyst for post war social change and liberation for women. This ‘equality of pay’ acceptance into the workforce would change social habits of mind thus offer job opportunities for women as teachers or as a Home Economist in charge of a department or writing for newspapers and magazines (New South Wales Department of Education, 1962; Stage, Stage & Vincenti, 1997). By the 1970’s, syllabus values turned to the transfer of knowledge and understanding of principles to develop the whole mind, body and soul. There was also a general move to develop the natural potential of people’s affective and motor innate capabilities for any job. The means to do that was through the study of various subjects that helped address a whole person’s development (Secondary School Board, 1976; Grady, 1970). The junior secondary syllabus in particular reflected Family Studies and Management in Home Living with the study in the science of food transitioning in and out of favour between the 1970’s and 1980’s. Although the senior syllabus carried a similar theme—but applied more the physical, biological and social sciences—the level of food science studied was a more inferior level compared to the 1960’s syllabus.
Contemporary technology curriculum

Technology education and food education

*What Employers Want*, a report tabled in 1987, aimed to identify what the ‘demand’ of business and industry needs were from the ‘supply’ end — schools. This led to The Carrick Review in 1989 that proved to be the most comprehensive review of school education in the history of Australia and set in place a massive review of education that produced the Education Reform Act in 1990 (De Miranda & Folkstead, 2009; McDonald & Gibson, 1995; Staples, 2008).

*Excellence and Equity* proposed a curriculum reorganisation of existing subjects into eight Key Learning Areas for secondary education. Technological and Applied Studies (TAS) was formed while existing subjects of Agriculture, Computing, Home Economics and Industrial Arts were required to redefine their purpose and relevance (L. Foster, NSW DET Chief Curriculum Officer K-12 directorate, personal communication, July 12, 2006). The overarching goal was to eliminate gender bias and promote inclusive education, advance knowledge about technology and design processes, develop practical skills and nurture a capacity for problem solving (Australian Association for Research in Education, 1993; McDonald & Gibson, 1995; Riordan & Weller, 2000). A second report was prepared in 1990 similar in context to the Carrick Report but a key issue of disagreement emerged between the Carrick and Scott reports concerning the power given to approve or disapprove courses of study to the Minister and that the Board of Studies acted as advisor to the Minister for patterns of study and course conditions. This removed responsibility of curriculum from the Department of School Education, and for the first time in NSW,
The NSW Design and Technology Syllabus Years 7-10, when introduced as mandatory in 1991, was seen as the core vehicle for interpreting the task of innovation based education. The Design and Technology ethos supported UNESCO values and at least on paper and in the intent of the syllabus rationale, the core aspect emphasised a need for students to build capacities that would help Australia’s future and quality of life. (NSW Board of Studies, 1991, p. 1). A Design Process was inclusive for each project undertaken that specifically guided students in designing, making, evaluating, communicating, marketing and managing (NSW Board of Studies, 1991a, p. 21). Before this there was not a cohesive body of learning in the curriculum called Technology Education where an integration of learning was encouraged across contexts.

The syllabus design was a move away from the teacher-directed, manual training approach to that of a creative facilitator role. Personal communication with a designer of the syllabus revealed that it unintentionally provoked a two-pronged debate: “what was useful and what was naïve”. R. Staples (NSW DET Chief Curriculum Officer K-12 directorate, personal communication, July 12, 2007) pointed out that it was “a useful curriculum for young people in terms of their general education and preparation for their future” but with regard to the teachers, “what we were naïve about was their approach to teaching and learning in that they were steeped in industrial practices of teaching”. Staples added that those teachers who embraced the syllabus were the ones who came from outside of a trade-based area. The teacher view placed a high priority on developing skills first before students could attempt design projects, which were largely open-ended. The syllabus supported a constructivist approach and many teachers were ill prepared to teach this new pedagogy (McDonald & Gibson, 1995). Its flaws were structural at worst, but its content...
and presentation was foresightful as a core vehicle for interpreting design and innovation education as a continuum from primary through to secondary education.

By 2003 all year levels of 7-10 TAS syllabi were reviewed for implementation in 2005. The new Design and Technology Years 7-10 syllabus was reclassified as elective rather than core status. This was largely due to the competing and more favoured traditional subjects of Technics, Technical Drawing, Food Technology (aka Home Science) and Textiles (R. Staples, 2008). The syllabus provided much creative scope but teacher interpretation exacerbated a lopsided presentation of the subject matter resulting in fragmented content and skilling preferences of teachers.

The 2005 Technology (Mandatory) syllabus on the other hand intentionally emphasised an object skills theme. The disparity in learning outcome distribution reinforces this view. For example the eleven design and innovation learning outcomes are given five pages of content whereas one learning outcome that refers to essential equipment skills is dominated by fourteen pages of content (NSW Board of Studies., 2003a, pp. 20-25; 26-40). The effect of this is two-fold: 1) pressure on teachers who are time-poor in the school timetable to distort and dismiss the eleven learning outcomes, and 2) it reduces any emphasis on design and innovation and largely predisposes a mode of teaching that increases content in more conventional manual skill and tool application. The situation opened a serious disparity between fundamental needs to engender design and innovation skills for the future.

In comparison the newly named junior and senior Food Technology syllabi in 1992 echoed similar values to the 1950’s syllabus — hospitality vs. the food manufacturing industry. Nutrition was heavily embed throughout the syllabus but there was a strong emphasis on independent research in which food innovations, environmental and ecological aspects
were studied at a senior level — Food science involved sensory perceptions of food (NSW Board of Studies, 1992). In 1999 food innovations was removed and replaced with native bush foods. Although there was a heavy emphasis on the Australian food supply and globalisation of the food industry and ownership of the food trade, both stands were optional (Nutrition and Australian Food Industry) but teacher preference leant toward nutrition. The junior syllabus by 2003 was taught and continues to be taught under the guiding principles of nutrition. While nutrition may encourage students to take Food Technology in the senior years, more often than not students choose Hospitality instead. Although the continuum from stage 5 to stage 6 appears to provide a sound lead-in on paper, there is very little correlation to food science, innovation or environmental aspects, as these remain a smaller dot points in both syllabi. This thesis argues there is simply not enough detail in the syllabus to get the message across for the real world issues at stake. Cooking tools and equipment rate high, particularly in the “student’s learn to” column. For example, principles of food preservation, properties of food, physical and nutritive effects of preparation and processing and nutritional aspects for health related disease are achieved through preparing and cooking food products (New South Wales Board of Studies., 2003b, pp. 18-21), rather than through instrument analysis.

The first review for the 2010 NSW Stage 6 Syllabus for Food Technology since 1999 resulted in amendments with a minor reshuffling of wording. Optional strands became core, all with equal weighting to ensure no bias in teacher preference could occur. The Food Technology syllabus dominates in nutrition (13) with very little food science (2) and no innovation or environmental aspects identified. Under the two dot-points for basic food science (sensory characteristics of food and functional properties of food), experimentation is undertaken through cooking recipes rather than through associations with chemistry, physics or instrumental analysis. This theme has played out over decades and the
disconnect in teaching food science and technology as perceived by the profession of food technology has posed a significant problem in advancing students into post school education in the food technology industries.

Out of the forty-five dot-points of learning, six broadly relate to the Food Technology industry. Where specified, ‘Economic Drivers’ in the syllabus concern retail purchasing, food processing and preparation skills, occupation and finances rather than the issues of food shortage and global warming presented in the literature thus far. Where the study of Food Technology is concerned, curriculum design methods should be clear about what it means in the wider world concerning food drivers. Cribb (2010, pp. 10-12) outlines the chief demand side drivers as “Population; consumer demand; population and demand” and points out these could easily be satisfied if the same tactics were used, similar to those from the 1960’s (Green Revolution farming technology), syllabus policy constraints prevent this as a solution. These would involve learning about the water crisis; land scarcity; nutrient losses; energy dilemma; oceans; technology; climate; economics, politics and trade. In terms of keeping the school study of Food Technology contemporary, these drivers should now reflect as core food curriculum rather than a fringe idea.

A key aspect raised concerns how well the syllabus can guide teachers and nurture creative and adaptive behaviour in students under the study of innovation and holistic technological practice given the key driver, innovation, has been displaced altogether as an area of study. It could be assumed that a solid understanding of Food Technology terminology would also be imbed in the curriculum, and as it is not and with the points previously raised, there is no requirement to teach as it is not an examination requirement (K. Tolley, Food Technology secondary teacher, personal communication, October 23, 2011).
This debate between conservative curriculum values and the contemporary demands that are upon it is not isolated to the subject of technology education or Food Technology specifically. Lewis (2004) directs us to Geography and Biology as subjects that share a similar history of struggle and where entry into the curriculum was surrounded by a utilitarian rather than an academic rationale. The literature review identified differences of rationale, method and application between technology and science, differences so great that the right positioning of the subject for the 21st century is crucial in this current major educational shift. Yet Rice (2010), executive director of the Australian Council of Deans of Science, revealed the secondary science curriculum fails to provide appropriate grounding in “real science” (para 1). Rice adds that the new National Curriculum will erode fundamental discipline understandings in the junior years by focusing on big picture ideas rather than learning scientific applications through physics, biology and mathematics as its core — elements of learning required in the senior years. The progression of learning between junior and secondary years is therefore questionable, but more problematic when students continue on to higher education where Rice cites chemistry and biology were the most commonly and extensively studied university subjects and in which emerging high school students had little depth of learning.

The weak emphasis on the organisation of science knowledge and the split into separate strands has produced a fragmented curriculum of topics that are vaguely described and loosely connected. It doesn’t paint a picture of what science is or what it means. It doesn’t give adequate signals as to the scope and depth of the topics treated, nor of how complex ideas such as energy or planetary processes are to be built up over time ... The curriculum then mistakenly describes the law of conservation of energy as a guiding principle rather than a scientific law (Rice, 2010, Para, 10, 12).

Regardless of Food Technology’s best fit in the curriculum, the subject ought constitute understandings of the highly dependent relationship with ecology, the people who initiate the agency of change and the tool/device environment that is mediating that experience. Robinson (Australian Broadcasting Corporation, 2009) identifies that economies are
shifting faster than what we have experienced in the past and points out that “the thing is that most reform movements are looking backwards; they’re looking back to the old system that was the result of the industrial revolution”. It is questionable whether Food Technology can achieve a best fit and thus offer a pathway succession into food science and technology undergraduate degrees from a curriculum that was intended as a general education, entrenched in vocational skilling. The next section explores the historical beginnings of Food Technology curriculum in higher education, contemporary accreditation constraints and the relationship between supply and demand contexts.

Food Technology curriculum in higher education

The first beginnings to systemise Domestic Economy for teachers occurred at Hurlstone Estate near Ashfield in NSW in 1869. Domestic Science was established by 1910 and thus set in place the “teaching of skills, knowledge, principles and attitudes” in domestic service (Peacock, 1982, p. 27). A typical pattern of study included Needlework, Cookery, Household Management, Laundry work, Hygiene and Human relationships. Topics included “money expenditure, clothing care, cookery, hygiene, first aid or home nursing, and relationship building with husbands and children” (ibid, , p. 39). Sydney Teachers College replaced Hurlstone in 1905 and offered cookery courses in Certificate 2 level. By 1910, the first Training School of Cookery commenced at the Fort Street Model School, then moved to Ultimo Technical College. The training school was later established as Domestic Economy at East Sydney Technical College in 1922 (Freyne, 2010; New South Wales Department of Technical and Further Education, 1983).

The first degree in Domestic Science was implemented at the University of Sydney in 1925, which offered a Bachelor of Science in Domestic Science (B. Sc. Dom). This was a three-year degree that required a pass in a matriculation examination equivalent to a Bachelor of Science degree in subjects such as Physics, Chemistry, Physiology, Botany
and Zoology. The degree was in conjunction with the Domestic Economy course at East Sydney Technical College. The problem with this degree was the competing time frames for course completion that extended the length of the university degree. For students leaving school before graduating with a Leaving Certificate, the most popular option was to undertake the technical education course instead. It is relevant to highlight at this stage that a university degree as a technology teacher was not attainable until the late 1960’s to early 1970’s, however technical colleges continued to dominate teacher education in the form of a teachers college. It is also relevant to point out that skilled tradespeople who worked as technology teachers under the Department of Education and Training over many years were awarded “a teaching certificate or later a teaching diploma” (Seemann, 2000) p. 3).

By the late 1980’s the role of vocational education and training had become enmeshed with the whole process of economic restructuring in response to economic changes. Arup, Howe, Mitchell, O’Donnell and Tham (2000) cite that during 1988 to 1992 a substantial consolidation of government policy occurred towards vocational education and training and where many teacher colleges, also known as ‘Colleges for Advanced Education’ between 1967-1999, began to morph into a university system. Southern Cross University is one such example. While the strong vocational and technical training push started to dissipate during the 1990’s due to a shift in the economy (manufacturing in Australia had increasingly moving off shore since the early 1980’s), the introduction of the Higher Education Commonwealth Scheme (HECS) for universities made it possible for students from low-income families to attend, whereas they may have otherwise entered into a vocational occupation. As a result enrolments dropped at TAFE colleges, and by 1990 the institution needed to reinvent itself in order to meet the changing market needs and rapid pace of technological developments in industry and commerce (New South Wales
The introduction of the New Apprenticeship System that aimed to provide more flexibility in responding to technological change and industry needs provided, a flush of money into a flagging VET system (Arup et al, 2000).

Since then several technology education teacher degrees emerged — but through policy rather than research. The dual package involved training through trade-based VET courses coupled with education units, a strategy used by government and private schools since the early 1830’s (Seemann, 2000b). Today, TAFE colleges offer articulated pathways into universities, which have resulted in some universities offering ‘fast track’ degrees (2 years) targeted at mature age industry people. The Bachelor Technology Education at Southern Cross University for example, places a strong emphasis on practical skilling and is therefore closely integrated with Vocational Education and Training (VET) courses as a requirement to teach VET course in schools. While the degree aims to attract school leavers, it specifically targets students studying technology related vocational courses at TAFE and mature age people “currently employed in technology-related industries but are looking for a career change, for example a chef, textile worker, graphic artist, computer technician or timber or metal tradesperson” (Southern Cross University, 2012, p. 1). The advance standing offered directly relates to trades such as carpentry, metal fabrication, graphic industries, fashion design, dressmaking and hospitality. For Food Technology specifically, HOS10199 Foodservice Operations and SCI00419 Food and Beverage Management are mandatory entry requirements (ibid, p. 1.8). Qualifications as a food technologist or food scientist or TAFE study as a Laboratory Technician are not considered as areas of study for advance standing in Food Technology. A similar traditional vocational/domestic cooking focus is evident in British postgraduate teacher training courses and one that that is so entrenched that it is difficult to integrate new ideas and ways
of addressing food production other than the common approach of just ‘making’ food (Rutland, Barlex & Jepson, 2005).

This vocational emphasis in Australia has enjoyed a renewed uptake since the introduction of Trade Training Schools in 2006 (NSW Department of Education and Communities, 2011). The current New South Wales Institute of Teachers’ document for Graduate Teacher Standards in Initial Teacher Education Programs for Food Technology (as a major and teaching degree accreditation) references directly to Hospitality. This thesis suggests a significant problem concerning the phrasing in this document reinforces a vocational skilling view for the word ‘food’. For example, the last dot-point under the phrasing for Knowledge of Subject Content 1.1.1. “Practice of design and production/manufacture in food and hospitality contexts” (New South Wales Institute of Teachers, 2011, p.33) does not make ‘food’ explicit as any particular industry but rather positions ‘food’ as reinforcing vocational operational skills. It would be useful to include food technology and science language in order to dispel any semantic problems.

It is clear from the literature that Food Technology competes with Hospitality. For example, in the 2009 archived statistics from the NSW Board of Studies 3,477 students studied Food Technology in the Higher School Certificate year, compared to 6,584 students who studied Hospitality with an exam, and 7,628 students who undertook Hospitality without an exam. In 2010, Food Technology enrolments reached 5,026, while Hospitality 2 Unit (26501) enrolments consisted of 11,587 students. It is also clear from the literature that Food Technology is not well supported in secondary schooling and is having an impact on career pathway choices by school leavers into the food technology and science industries and where there is now a serious shortage in filling available jobs (Education Providers Working Group of the Australian Institute Food Science and
Aside from the vocational operational skilling in schools, it is timely to ask: why should students in NSW schools learn how to make food? The Curriculum Corporation (2011) presents Food Technology as a way to understand food properties through cooking processes. Nutrition and consumption are also important aspects and “students learn to evaluate food choices in a range of contexts and to consider technological, cultural, economic, social and environmental factors”. L. Foster (K-12 Chief Curriculum directorate, personal communication, July 12, 2006) believes studying food in schooling provides a broad base of knowledge and skills that are applicable to all aspects of one’s life, so is an important framework for learning, thinking, creativity and problem solving. Foster adds that studying Food Technology is not necessarily offered as a job pathway, and argues quite strongly that it is not a subject that is purely about career choices but in fact it is a general education in health and well being that has great value for anybody whether they choose Food Technology as a career pathway or not.

Vocational courses were written to have a vocational pathway. The general education courses which are the technology courses are general education: which means they are there for all students regardless of where their career paths may take them. So that is an important difference to make (ibid).

On the other hand, Karmel (2010, para 1) argues, “Much of VET needs to be thought of as general education, if with a vocational orientation”. This dual position offers an interesting debate concerning the shift in meaning for general education. Life skills was not in the language of educationalists during the late 1970’s to early 1980’s, but rather general education was meant as a transferable knowledge and understanding of principles to develop the whole mind, body and soul. The general education movement was to
‘develop’ the natural potential of people’s cognitive, affective and motor innate capabilities for any job (Mackenzie & Evans, 1946).

In theory, universities are meant to be the gatekeepers of intellectual knowledge in the liberal arts and the theoretical sciences but are increasingly embracing occupations not associated with higher education. Alternatively, TAFE colleges have repositioned themselves to now offer fellowships and post-graduate degrees as a measure to meet the gap demand in (domestic) higher education. Where once universities and TAFE colleges were seen as distinctly separate sectors, they are increasingly becoming inextricably linked (Karmel, 2007; 2010). It is argued that technology education degrees offered in NSW are increasingly being constrained by the vocational view held by the accreditation and curriculum authorities. In particular, the introduction of the new and rigid hierarchy for teacher and teacher training accreditation puts at risk the scholarly and deep skill study of technologies as it is unlikely to be viable in most schools given the anecdotal evidence thus far, but instead life skills and VET appear to be professionally and economically viable.

A sub question for this thesis leads into the following section, which broadly explores the food technology and science industry from its First Fleet beginnings to the evolution of scientific knowledge, policy and technological innovation: What is the evolution of policy and industry knowledge in Food Technology? The historical relevance between food, science and technologies ought have more emphasis for study in the senior food technology syllabi as this discourse plays a fundamental role in human agency and events that bring us to the present. Higher education food industry curriculum is compared and contrasted with the school view as a way to identify how well both sectors are aligned.
Evolution of food science and technology industry and industry curriculum in higher education

The new beginnings in Australia for the early settlers were far removed from the well-established industrial economy of Britain and as a result the food technology and science industry took twenty years to become food sufficient as a colony. Pre 1800’s technology dominated over science but science eventually improved technology. This opened up the scope to produce new food innovations (Annison, 1999; Farrer, 1999). The catalyst for food policy was driven through the growing body of scientific knowledge around the nature of food, the gradual understanding of nutrition, and a recognition and understanding of the role of micro-organisms. This research during the 1780’s was mostly by entrepreneurial men from England, America, Germany and France. These entrepreneurs were quick to diffuse their ideas and transfer technologies to Australia (Australian Science and Technology Heritage Centre, 2010; Farrer, 1995).

Between the 1800’s to the 1900’s an explosion of technological developments manipulated ingredients into edible products (roller milling of cereals; separation of milk; pasteurisation of milk and cream; refrigeration of meat and dairy products; cool storage of fruit; mechanical dehydration, and fermentation in the brewing industry). Critical scientific developments were introduced to the sugar industry, while yeast research by Bavay and cereal science by Farrer and Guthrie set in place a rapidly growing food technology and science industry (Farrer, 2005). It was not until the 1920’s that chemists, already core workers in food science and technology since the 1800’s, became involved in food processing.

Technical developments in agriculture, food processing and preservation produced a strong export commodity through the existing knowledge of salt as a preservation technique for
meat, while refrigeration developed in 1851 and superseded the well-established canning industry since 1815. This cold storage development led to patents for quick, frozen foods by the 1920’s (Green, 1985; Farrer, 1999) but it was not until the 1940’s that frozen food had uptake from consumers in America due to the expensive and slowly evolving ‘freezer chain from factory to consumer’. This did not occur in Australia until the 1960’s, although food irradiation was developed during the 1950’s but with limited applications. As new scientific knowledge unfolded around the nature of food (nutrition, micro-organisms, food and chemicals) legislation, regulation and control systems were developed. Food legislation, like education, followed the standards set in Britain but America also played a significant aspect in food policy as well due to their sophisticated scientific, technological and engineering techniques. The post-war years produced a surge of innovation and knowledge growth that accelerated the economy away from ‘land, labour and capital’ (Fee, & Seemann, 2002) to the diffusion of ideas and products through research and development. Yet food science and technology in Australia was not was not fully recognised as a discipline area, particularly in the canning of food for the armed forces, until the end of the Second World War, (Green, 1985).

With the introduction of educational reforms the gradual diffusion of food technology and science into higher education programs began. Associations and food institutes emerged as a way to share new knowledge and keep the growing food industry informed through scholarly research ⁴. This is an important aspect from the literature as it demonstrates a dynamic discipline that sought to innovate. Various scientific societies ensued from London and formed in Sydney, while the Society of Chemical Industry of Victoria

⁴ 1945 - Food Technology Association (FTA)
  1945 - The Council of Australian Food Technology Associations
  1945 - The Australian Journal of Dairy Technology
  1967 - The Australian Institute of Food Science and Technology
followed shortly after. These were independently run but modelled on the British model with membership drawn from industry, academe, and public analysts (Australian Science and Technology Heritage Centre, 2010; Farrer, 2005; Farrer, 2005; University of Melbourne, 2010).

Early training began at the Hawkesbury Agricultural College in NSW at the end of the 19th century for dairy technology in butter and cheese; wine makers were enrolled at the South Australian Agricultural College at Roseworthy (Farrer, 2005; Australian Science and Technology Heritage Centre, 2010). There was no tertiary course per sé, but rather lectures via the Australian Chemical Institute in Sydney. Eventually, Sydney Technical College started training in food technology in 1942 with a six-year part-time course established by 1947 due to strong demand by those in the canning industry who were interested in learning the science of food rather than through the trial and error process of past decades (Farrer, 2005). By 1951 a two-year diploma course was established at the Hawkesbury Agricultural College. Conversely, the first universities were established in Sydney (1882) and Melbourne (1884), each with their distinct scientific focus, but both prospering in engineering science. The University of New Southern Wales offered a food technology course in 1953 with Colleges of Advanced Education also offering higher degrees for work in government laboratories. For example, the Commonwealth Science and Industry Research Organisation (CSIRO) in Melbourne, and Sydney and Dairy Research Laboratories in Brisbane were strong employers. Research and Development industry practice offered much employment (Australian Science and Technology Heritage Centre, para 2, 2010) 5. From an industry perspective, the Commonwealth Science and

5 1947 - Bread Research Institute in Sydney
1949 - the Sugar Research Institute in Queensland
1955 - Australian Wine Research in South Australia
1955 - Kraft in Melbourne, Unilever in Sydney, and the Queensland Butter Board in Brisbane
Industry Research (CSIR), established in 1937, produced scientific and technological knowledge in the dairy industry that contributed to global innovations in dairy technology. The Division of Food Preservation and Transport also expanded scientific work in chemistry. Today, there is strong representation for degrees in food technology and science in Australia. At the time of writing this thesis, Table 1 outlines the availability of courses offered nationally (Australian University Directory, 2011).

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<tbody>
<tr>
<td>Bachelor of Science (Nutrition and Food Science) University of Western Sydney</td>
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<td>Bachelor of Food Science and Human Nutrition University of Newcastle</td>
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<td>Bachelor of Health Science (Food and Nutrition) Charles Sturt university</td>
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<td>Food Science and Technology Group School of Chemical Engineering, UNSW</td>
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<td>Bachelor of Science degree (Nutrition, Food and Health Science) Victoria University</td>
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<td>Diploma of Food Science Technology course Victoria University</td>
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<td>Food &amp; Nutritional Sciences University of Ballarat</td>
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<td>Master of Food Science University of Melbourne</td>
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<tr>
<td>Bachelor of Science (Food Technology &amp; Nutrition) RMIT</td>
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<td>Bachelor of Food and Nutrition Science University of Adelaide</td>
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<td>Master of Food Science University of Western Australia</td>
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<td>Master of Food Studies Queensland university</td>
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**Table 1: Australian university degrees in Food Science and Technology**

When a student completes school in Year 12 and then enters a degree in Food Technology, they should feel comfortable in knowing they are studying a continuum from school-based Food Technology that is aligned to the wider professional view. The following section
explores the continuum of learning between food technology schooling and food technology higher education. The need to understand this more was first identified during the scoping stage for this research and also through phone conversations with food technologists. Personnel conversations with food technology academics at the University of NSW and the CSIRO commented that many students who come from school having studied Food Technology are not academically prepared to study either the Food Science and Technology degree or the Food Science and Nutrition degree. Many students drop out in the first month before the census date because “it was not how the subject was taught at school” (B. Cox, CSIRO food technologist, personal communication, October 12, 2008; Dr A. Lee, food technology and science academic, personal communication, March 24, 2009).

Two sections, the Scope of the Study, and Social and Environmental Systems Analysis discussed the need to strengthen educational outcomes for the knowledge economy through scientific research and education, entrepreneurship and creativity. The DEST (2003) report, Australia’s Teachers Australia’s future, outlined the need for education (secondary schooling and higher education) and industry to work together as the twin engines for change. While this document acknowledged the transition from secondary schooling is not always a linear process, a recommendation outlined the need for the transition from schooling to undergraduate degrees be more streamlined. It was advocated teachers access industry professional development so that up to date knowledge could be transferred into the classroom. In addition, business and industry expectations were seen necessary for shaping the broad goals and purpose of schooling. This is particularly relevant for the subject Food Technology. Since the DEST 2003 report was published, articulated pathways from secondary schooling including pathway programs combining VET and higher education, in conjunction with industry, continue to strengthen the link
between education and the changing needs of the labour market (NSW Government, 2012). At this juncture it is important to explore how well secondary curriculum content reflects a pathway into an undergraduate Food Technology degree.

Table 2 shows an example of unit content studied in the Stage 6 Food Technology Preliminary and Higher School Certificate years in the top column, mapped with units of study from the University of NSW undergraduate Food Science and Technology degree (University NSW, 2011). The Food Science and Nutrition plan showed similar unit disciplines but contained an extra nutrition unit plus an elective. Units and electives that map from secondary schooling into an undergraduate degree as assumed knowledge are shown in bold and italics, with the quantity of dot-point unit study in brackets. The mapping exercise aimed to identify similar or contrasting patterns in learning content between both groups. There is a pattern to suggest a poor continuum of learning in the sciences from the secondary syllabus, but there is a strong pattern to suggest a high emphasis is placed on nutrition and the manipulation of ingredients through technology used to produce a product. Basic science also referred to as ‘organic science’ in the literature, but has a lesser value assigned as a study area (Brown, Foote, Iverson & Anslyn, Novak, B 2012).

Table 2 also demonstrates that a food science and technology degree requires prior knowledge in the sciences, particularly chemistry with nutrition given less emphasis. This is relevant to the literature as nutrition is an area that is strongly favoured by teachers. Although the Australian Food Industry is studied at a secondary level, the learning concerns legislation and policy with a broad overview of the agri-industries with some similarities to Product Development (Burnett-Fell & Stutchbury, 2010). It is posited that while Product Development is consistent with the food technologist’s approach as “one who applies food science to the preservation, processing, and preparation of foods, and to
their packaging, storage and transportation” (Green, 1985, p. 6), the heavy emphasis toward this approach ought to be reduced to accommodate cross curricular unison with the science department. Food scientists also play a role in Product Development so it makes sense that students ought be exposed to the food scientist’s role as “one who studies the basic chemical and physical, biochemical and biophysical properties of foods and their constituents” (Green, 1985, p. 6). Therefore a more holistic understanding of food technology and science would be achieved and thus provide a more beneficial continuum of learning from secondary to higher education.

<table>
<thead>
<tr>
<th>Stage 6 Food Technology Preliminary and HSC</th>
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<tbody>
<tr>
<td><strong>Nutrition</strong>, diet and health (13)</td>
<td><strong>Australian Food Industry</strong> (4)</td>
</tr>
<tr>
<td><strong>Ingredients</strong> and materials (9)</td>
<td><strong>Basic food science</strong> (2)</td>
</tr>
<tr>
<td><strong>Technology</strong> use (9)</td>
<td>Economic drivers (2)</td>
</tr>
<tr>
<td><strong>Product development</strong> (6)</td>
<td></td>
</tr>
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</table>

**Food Science and Technology degree**

| Chemistry (6)                              | Sustainable food manufacture (1) or |
| Biochemistry (1)                           | **The food industry** (1)          |
| Microbiology (2)                           | **Operations in food processing**; (1) |
| Molecular biology (1)                      | **Food safety and quality** (1)    |
| Molecules, cells & genes (1)               | **Food preservation** (1)          |
| Instrumental Analysis (1)                  | **Food processing principles** (1) |
| Food technology lab (1)                    | **Product design and development** (1) |
| Industry liaison & practicum (3)           | **Nutrition** (1)                  |
| General education (2)                      | Electives: Biotechnology, Microbiology; |
| Thesis (2)                                 | Forensic Science, Nutrition, Physiology, |
| Life and Social science: Math (1)          | Macro and microeconomics; Business |
| and Statistical Analysis (1)               | management, **Marketing**; Food processing. |

*Table 2: Senior secondary and university course study*
In the NSW Board of Studies 2010 HSC Student Report, Food Technology was listed at the lower end of courses as ‘challenging’ (3.6/5) and ‘relevant’ (3.7/5) while Hospitality was listed as second from last as ‘challenging’ (3.3) but having higher relevance (3.8). This is a critical fundamental factor that makes transparent the disconnect between the schooling view of Food Technology and what the subject ought constitute from a food technology and science industry perspective. Additionally, nutrition and consumption are important learning at a young age, yet it is questionable how well nutrition and health have been taught in schools, given Australia has one of the highest prevalence of obesity and health related disease in developing countries (Colagiuri, Colagiuri, Magliano, Shaw, Zimmet & Caterson, 2010). The study of nutrition would serve students well through practical based experiments and assure continued effective diversity of food-based curriculum in secondary schools.

While it could be argued that the study of food product development is valuable in a general education design context, the curriculum content studied is not enough to provide an adequate pathway of learning into an undergraduate degree in food technology and science/nutrition without sound knowledge from studying Chemistry as well. Chemistry and Biology remains core to understanding living systems and these subjects offer innovation in every link of the food chain (Brown et al, 2012; National Research Council of the National Academies, 2009). This wider context presents a compelling case to rethink the future and content of food technology education given the current need to be clearer by what is meant in the subject matter and language for the next generation of curriculum design.

Desktop research to this point skipped over centuries and compared the purpose and context of technology and food technology education across three countries. The literature suggests the subject matter has not evolved. That is, there has not been a clear effort to
define the nature of knowledge itself based on research and scholarship. Therefore the
subject’s definition remains contestable given the plethora of literature around
‘technological phenomena’ and ‘varying personal perceptions’ (Keirl, 2003). Because of
this the school system has started to self-reference itself rather than grow as a dynamic
field that seeks to innovate compared to the food science and technology industry. A core
problem identified is that the subject has not demonstrated the capacity to articulate a
schema as a way to frame or understand the subject matter.

It is useful at this point to return to the third research question: How can forms of
technology practice be identified in Food Technology education? The following sections
critique a selection of frameworks that guide the study of technology and food technology
education. The next section in particular discusses the origin of the framework used for
this thesis and endorses the framework as the most suitable structure for identifying forms
of technological practice for this research.

2.1.5 A Curriculum-based Political Analysis

2.1.5.1 Technacy education in purpose and context

Technacy education was first introduced in the late 1980’s at the Centre for Appropriate
Technology, Alice Springs, in the Northern Territory, Australia. Ancestral indigenous
knowledge and socio-technical systems underpin Technacy Theory through the practice of
being able to produce an artefact, tool or shelter that involves the integration of social,
technical and material elements in harmony with the environment. The theory is involves
a nested system where subsections can each define a purpose or context and where each
element is interdependent of each other. In concert with this theory, historical western
proponents for a schema that integrates social, cognitive and material experiences have
been identified through the literature and writings of Hegel, Feuerbach, Marx, Ihde, Schumacher, Mumford, Papanek and Dewey. However, common to contemporary technology education learning, independent parts tend to segregate rather than act as a whole system of integrated learning.

The general elements of Applied Setting (including time), Human (as Agent), Tool and Environment are well placed to be the necessary basics to any holistic human technological activity. How and why these elements work together, their schema, are referred to as the ‘basic principles’...the thesis is that Technology cannot be reduced to less than these general elements and as such, Technology is their product. We therefore may need to understand and teach these elements and their relations to each other explicitly, in ways that reveal the utility of such understanding when making technical choices and design decisions for all the genres of technology and at all their scales of application and discovery. The case is made for technology to not merely be a ‘know how’ learning experience, but necessarily also a holistic ‘know why’ learning experience essential for developing and transferring technology knowledge (Seemann, 2003, p. 28).

These basic principles offer a way forward for teachers to frame a genuine education in technology as a “holistic approach to perceiving, teaching, practicing and learning” and therefore a useful tool for any technological contexts (Seemann & Talbot, 1995, p. 761). Drawing on Seemann and Talbot’s earlier work, Technacy is described as a “three way dialectic of necessarily interdependent parts” (Seemann & Talbot, 1995, p. 768). Diagram 8 shows how the three factors are positioned independently, but when intersected become interdependent parts.

![Diagram 8: Venn’s logic for integrating parts](Seemann & Talbot, 1995, p. 768)
Diagram 9 shows when integrated, M becomes central to the three factors; that is each element exists in a dependent relationship with the other elements of practice, and defines the purpose and context of application (M). The three elements around M are both resources and constraints that are evident in all forms of technological practice (Seemann, 2003, 2009).

Diagram 9: Technacy logic for integrating parts

(Seemann & Talbot, 1995, p. 770)

Diagram 10 displays the marginalisation from ‘a’ to ‘b’, of any given element (human, tool, or material/ecology) where an element is in favour of another, thus an unevenly distributed outcome prevails. The objective is to arrive at a balanced view that acknowledges the heavy reliance that technological choices and processes share with their social and ecological drivers (Turner & Seemann, 2010a).

Diagram 10: Technacy as an equaliser for technological practice

(Image courtesy Newcombe, 2008)
Technacy contains the essential elements of a good theory, which, according to Hawking and Mlodinow (2010, pp. 51, 52), ought to be “elegant but simple”. It is declared that Technacy Theory is in itself is an elegant but simple theory, and is arguably the most useful contemporary framework for thinking about the underlying pattern under all technological activity, and to measure and guide technological outcomes. Various scholars have endorsed Technacy in terms of its socio-technical elements and value in experiential learning. In particular, Technacy is an enabler for connecting projects to real community needs through developing the capacity in students to research, analyse and synthesis information in a technological context (Australian Science Technology and Engineering Council, 1996; Fleer, 2000; Fleer, 200a; Fleer, 2002; Fleer & Jane, 2004; Northern Territory Government, 2003; Parnell, 2012; Ramsey, 2004; Seemann & Talbot, 1995; Walker, 1989 & Walker, 2000). Parnell (2012) rightly points out that motivation is another enabler to apply the knowledge and skills in order to bring about change and to reflect on real-world action and experience. Critics against this theory have yet to come forward in the literature.

In 1991 Technacy education as a national project was the recipient of an innovation award from the Australian Association of Adult and Community Education. The Certificate in Applied Design and Technology ATWORK (Aboriginal Technical Worker) was established in the early 1990’s. The programme aimed to enhance literacy and numeracy skills through practical technical work and thus improve the literacy and numeracy learning outcomes in the programme. Subjects included: literacy, numeracy, technacy, health hardware, appropriate technology and the development of practical skills through a hands on, in-community approach (Seemann & Talbot, 1995; Walker, 1989). The programme was structured to suit the learning needs for Aboriginal people, an important human element that was missing from mainstream TAFE courses. Technacy was endorsed
as a fundamental new approach in 1995 by the United Nations Educational Scientific & Cultural Organisation (UNESCO) journal *Prospect*. In 1996 the Australian Science Technology and Engineering Council (ASTEC) selected Technacy as the single most significant general capability required for all teacher training and curriculum by the year 2010. Of the priority actions accepted in the report, priority number eight stated the need to incorporate ‘Technacy’ in primary and secondary school curricula teaching practice.

For many years literacy and numeracy have been the cornerstones of western industrialised education. Yet there are basic skills in technology and problem solving which are required to support a technological lifestyle. ASTEC considers that technacy provides a sound framework for developing a new vision of the role of the S&T system in achieving national goals and improving understanding of S&T in the Australian community (Australian Science Technology and Engineering Council, 1996, p. 62).

In 1999, the vision for a futures thinking degree aimed at building social and environmental knowledge capacities in technology education came to fruition. Central to the degree was Technacy Theory, studies in the knowledge and innovation economy, research ethics and principles, and cross-cultural aspects. The NSW DET Chief Curriculum Officer noted the degree as:

> Cutting edge in the state, particularly in indigenous technology, research and innovation studies (Foster cited in Seemann, 2004, p. 4).

The degree also received much acclaim by Fleer, a leading Monash University Professor:

> The design of the program is innovative, is well placed to produce leading thinkers and practitioners in technology education and is leading edge relative to comparable programs (Fleer cited in Seemann, 2004, p. 4).

What was integral to the degree was the relationship between people, technology and the environment as complex adaptive systems. The degree folded officially in 2009 with a radical direction change to a VET orientation view. This was largely due to the traditionalist perspective held by the new NSWIT accreditation authority previously discussed and stakeholder ideologies at the time. The name ‘Bachelor Technology Education’ was retained in the new course review even though the new content opposed
the original ethos underpinned through Technacy. It could be argued that this was due to the outstanding status the degree had maintained for ten years and would be the reason that it would continue to draw students into the degree based on reputation. In 2003, Technacy was significantly highlighted throughout a commissioned report to the Northern Territory Government, *Report on the Future Directions for Secondary Education in the Northern Territory*, with recommendation number 9 outlining the following:

> The NT Government, through the Minister, take up with the appropriate Ministerial Council the feasibility of a national testing regime for technacy to parallel testing for literacy and numeracy so that standards can be established for these skills; and that NT DEET undertake preliminary work in this area which may be presented at appropriate forums to bring the issue onto the national education agenda (Ramsey, 2004, pp. xxi, 56).

Dr. Gregor Ramsey chaired the committee to form a national teacher accreditation board, and chaired and authored the NSW Review of Teacher Education that directly lead to forming the NSW Institute of Teachers. After undertaking this role in NSW, he was then commissioned to do the same for secondary education in the NT where he wrote:

> This review has also identified the importance of developing technacy* skills – critical skills for negotiating the varying and ever changing technologies increasingly integral to daily life, even on remote communities. Our social lives are becoming more and more technologically textured (Ihde, 1990, p.1), and this demands teaching and learning pedagogies that allow students to engage authentically with our technologically constructed worlds. Technacy skills are not an ‘add on’, although in a number of classroom environments teachers were struggling to do just this, that is, to fit the technologies into traditional classroom structures and practices. Where innovative models of teaching and learning were occurring these were being augmented by new models of technology use, and participants in these learning environments were not only developing technacy skills but also skills in how to transform information into knowledge. Significant research into how the development of technacy skills and their applications in the diverse contexts of the NT may augment and transform learning and the purposes of learning needs to be undertaken (Ramsey, 2004, p. 57).

The NSW Board of Studies in 2003 included the phrasing for Technacy in the Design and Technology Years 7-10 elective syllabus. For example, in the ‘Learn About’ section,
under human, technical and environmental factors, key phrasings are evident and are outlined below:

1. Human capital (knowledge, skills and techniques)
2. Appropriateness of technology choices and design decisions
3. Social and environmental sustainability
4. Resource choices and availability (tools, materials, time, finance)
5. Ergonomics
6. Safety, values and ethics

In 2004 Professor Marilyn Fleer included Technacy Education in the book *Technology for Children*. A book section highlighted Technacy as a cultural framing tool for technology while noting the socially constructed view of Technacy as “a radical new way to incorporate technology in the curriculum in order for students to become competent in holistic technology practice” (Fleer & Jane, 2004, p. 180).

During 2006 to 2008, Technacy underpinned a successful national research project funded by the Australian Government Curriculum Corporation and co-sponsored by the Desert Knowledge Cooperative Research Centre. The Australian Schools Innovation in Science Technology and Mathematics (ASISTM) project partnered Southern Cross University, Desert Knowledge Cooperative Research Centre, and ten NSW schools. The fifteen-month project connected twenty-seven teachers, Aboriginal Liaison officers, and students from coastal-rural fringe areas with desert approaches to ingenuity by cultures from central Australia. The project pioneered new ground in mainstream teaching and learning that involved the development of a new taxonomy of learning in technacy and innovation:

*It is informing and inspiring mainstream pedagogy from contemporary Aboriginal and outback innovation and ways of thinking about teaching and learning in any technology genre. It aims to guide classroom*
teachers in their journey to produce a chart of ‘Appropriate Experiential Expectations” of indicators for technacy and innovation capabilities that include video vignettes and images as evidence of those indicators. The goal being to build more effective, evidence based, pedagogy in various technology genres among learners that fosters innovative attributes thus offering a foundation linking literacy, numeracy and technacy across curriculum and within appropriate domains. The process challenges teachers and learners alike, to unlearn much acculturated conventions in understanding technology and learning anew, sets of practices that add value on previous frames of reference (Seemann, 2008, p. 1).

Over the lifecycle of the project, Aboriginal and non-Aboriginal teachers in collaboration with academics in primary and secondary education produced a prototype chart of developmental indicators across different subject domains. Additionally, the Alice Springs Declaration on Technacy and Innovation Education was also formed:

We educators and learners hereby declare that: We will foster and advocate technacy and innovation capability across curriculum and in teaching practice, in the interest of our common sustainable future. We also acknowledge inspiration from desert people's ingenuity and the relationship between people, technologies and our environments that as a system offers both ideas as well as challenges for assuring intergenerational fairness (Cheers cited in Seemann, 2008, p. 19).

Technacy education continues to gain momentum and interest amongst educators in other states. In Victoria, for example, Yea High School developed a new Learning Age Options curriculum for year 9 and 10 students in 2011. The course of study aims to provide students with appropriate skills for the 21st century and provides two options: ‘The Connected Learning Option’ and ‘The Big Picture Option’. Technacy as a subject/learning goal is positioned under the Connected Learning Option where the design process under the Technacy framework involves “Investigating and designing; Creating and making; Exploring and responding; Analysing and valuating, and ICT skills”:

The Connected Learning Option is based on a core curriculum of English, Mathematics, Health and Physical Education. Sport Education sessions are held jointly with all students in Year 9 and 10 being involved. Similarly, all students in Year 9 and 10 work together in Technacy which embraces a range of studies including materials technology, information communication technology, art, graphics, multi-media and food technology. Tasks for Connected Learning students in Technacy will be, in part, teacher directed and partly developed by the student in consultation with their teacher and signed
Under the Big Picture course, Technacy acts as an advisory component in examining technological solutions to problems. This thesis argues core to transforming education policy and practice with current economy needs involves a curriculum that aspires to holistic, constructivist education rather than the ‘functionalist/industrialist’ models presented in the literature. It makes sense that if education functionaries underpin literacy and numeracy as cornerstones in education, then Technacy has a vital role to play in accelerating literacy and numeracy skills that includes being technate.

2.1.5.2 Comparative analysis of conceptual frameworks

Contemporary frameworks can often be complex in structure and learning or heavily skewed toward design, while others appear to respond to change and challenges. This section critiques a variety of technology frameworks that present visually interesting and creative diagrams on one hand but reveal on another level that technology educators still struggle to identify what constitutes the study of technology. Design is perceived as a general capability, yet the following frameworks do not convey how designers think but rather have their individual stamp or recipe for a design process – all fell short in being able to identify and measure inter-relationships and subtle differences between typologies of technology practice in relation to sub question b) for this thesis: How can forms of technology practice be identified in Food Technology education?

America

The American standards are representative of science and engineering specifically, with technology and design integrated. The standards are organised into five major categories: 1) The Nature of Technology, 2) Technology and Society, 3) Design, 4) Abilities for a Technological World and 5) The Designed World. Twenty standards under the five
categories collectively present a somewhat complex framework. Although this model is able to identify a context, technological processes and knowledge, this model does not make transparent materials and ecological aspects and as such was not useful for the purpose of this study.

Diagram 11: USA framework for the study of technology

(Dugger, 1997)
New South Wales

The NSW approach in Australia is driven through an iterative management process. This framework aims to use a common language for design aspects that is suitable for both primary and secondary (K-12) education that explores and defines a task [considers the user, the client, the available resources and social, ethical and environmental issues]. This model is useful as a design process in that it can define tools, materials and techniques used in a design project, but this model cannot define a purpose or context nor identify how each element is interdependent of each other to achieve a balanced outcome for technological activity. This model also fails to identify and measure inter-relationships and subtle differences between typologies of technology practice.

Diagram 12: New South Wales framework for the study of design and technology

(New South Wales Department Education and Training, 2011)
Victoria

Victoria’s framework for Design, Creativity and Technology is an interdisciplinary strand interwoven with Physical, Personal and Social Learning and Discipline Based Learning under the whole-school curriculum-planning framework. The Design, Creativity and Technology framework considers human, tool, material/ecology aspects and economic factors over time. ICT skills are emphasised to visualise thinking, creating and communicating across three dimensions. Although this framework collectively cannot identify and measure inter-relationships and subtle differences between typologies of technology practice, the Interdisciplinary Learning section draws on technacy elements under Design, Creativity and Technology and as such is able to define a purpose or context for technological activity.

Diagram 13: Victoria framework for design, creativity and technology

(Victorian Curriculum and Assessment Authority, 2009, p. 6)
South Australia

The Design and Technology learning area for the South Australian curriculum is structured around critiquing, designing and making as a strategy to capture ‘knowing, understanding and doing’. Students critique past, existing and proposed designs and technologies by questioning lifespan, intention, design, construction, and use or misuse. Students are also exposed to cultural, economic and environmental aspects that are influenced by technologies. The interdisciplinary nature of the subject provides for the development of critical thinking skills, the knowledge and the understanding of materials, tools and techniques. Overall this curriculum holistically explores the interplay of technologies with people, society, the economy, and the environment—all aspects connected to Technacy Theory. The framework is not able to identify and measure inter-relationships and subtle differences between typologies of technology practice.

Diagram 14: South Australia framework for design and technology

(The State of South Australia, Department of Education and Children’s Services, 2004, p. 7, 9).
Western Australia

Technology in society forms the nucleus of the framework for Western Australia’s study of technology. Students learn to understand cultural beliefs, values and ethical positions interconnected in the development and use of technology enterprise. Although this framework cannot identify and measure inter-relationships and subtle differences between typologies of technology practice, the framework has the potential to identify design consequences and evaluate appropriate technologies through ethical and moral grounds under enterprising strategies.

Diagram 15: Western Australia framework for design and technology

(Government of Western Australia Curriculum Council, 2011, p. 293)
Queensland

In Queensland, an inquiry approach is used to nurture design knowledge. Students gather knowledge through:

- Investigation — gathering knowledge, ideas and data to meet design challenges
- Ideation — generating and communicating ideas that meet design challenges, and justifying the selection of these ideas
- Production — identifying, describing and managing procedures when making products that meet design challenges
- Evaluation — making judgments about the appropriateness of design ideas, processes and products when meeting design challenges (Queensland Studies Authority, 2011, p. 12).

This model contains a very strong design theme and ‘object’ focus as a way to solve real world problems. While it could be argued designing to solve real world problems is virtuous, the focus on a finished product only is questionable and not relevant for use in this study.

Diagram 16: Queensland framework for design and technology

(Queensland Studies Authority, 2011, p. 12)
Tasmania

Vocational and Applied Learning sits at the core of the Tasmanian syllabus for technology education. The strands are intended to interconnect as elements to enable holistic learning. The use of the name ‘Preferred Futures’ is a valuable strand for learning, although the school curriculum view in this instance contains a different meaning compared to the literature. Where Slaughter (1999) describes Preferred Futures as a way to “enable the projection of a rationale for sustainable futures pathways that provide a clear understanding of the past, why it was that way and the relationship with politics and economic drivers as change agents over time”, the school view focuses on the individual goals to achieve learning outcomes that “reflects upon personal strengths & interests; set personal goals; develop participation skills and learn about life and work” (Department of Education and Training Tasmania, 2011, p. 8).

Diagram 17: Tasmania framework for design and technology

(Department of Education and Training Tasmania, 2011, p. 8).
Northern Territory

Interconnected phases define the Northern Territory’s framework for the Technology and Design learning area. Indigenous perspectives are woven through three inter-related strands. This framework also draws on a core concept of technacy theory through predicting and evaluating the impact of decision-making processes and cross-cultural transfer of technologies across communities. While this framework cannot identify and measure inter-relationships and subtle differences between typologies of technology practice, the framework is useful in identifying the interdependent relationship within technological practice.

![Diagram 18: Northern Territory framework for design and technology](image)

*Diagram 18: Northern Territory framework for design and technology*

*(Northern Territory Government, 2010, p. 400)*
The Australian Capital Territory

The study of Technology in the Australian Capital Territory is structured as interdisciplinary learning but constitutes a fairly simplistic and design based view. The student designs, makes and appraises using technology in a variety of settings, such as textiles and design, food studies, design technology, technical graphics, information technology, computer applications and wood construction; common subjects in Australian schooling. However, learning is structured through developmental bands of age, with essential learning achievements assigned for age: 1) Early Childhood; 2) Later Childhood; 3) Early Adolescence; and 4) Later Adolescence. The content for learning is at the discretion of the school in consultation with the community. While this is an innovative approach to curriculum design, it is very much based on a teacher’s personal view for the study of technology education. Given the broadness of this curriculum it is not suitable to draw on as a point of reference to identify and measure inter-relationships and subtle differences between typologies of technology practice.

Diagram 19: Australian Capital Territory framework for design and technology

(ACT Department of Education and Training, 2009, p. 73, 236)
Political ecology

Petrina offers a series of multi-discipline frameworks to make explicit “technical-empirical, socio-political and ethical personal dimensions” (1998, pp. 122, 125). This beneficial framework evolved toward a more sophisticated set of design sustainability principles as a ‘cultural circuit’ of interconnectedness of products, streams and wakes as a way of expressing cultural ecologies. Political Ecology was identified through ‘designing conditions and processes’, which involved ten cycles as resource streams around a larger encompassing product cycle. For example, cultures, moralities, commodities, labour, capital, geographies, resources, economies and ecologies flow through each other around refuse and waste. Petrina’s core argument is to address the ecological footprint in our built environment, which he projects as the beginnings for Eco political literacy skills (ibid, 2000). The circuit of culture shown in Diagram 20 takes a complex political ecology when the ecocentric moment of waste is introduced. Diagram 21 emphasises the political ecology of design and technology as involving conditions and processes. Resource streams flow through each of the ten cycles and the larger, encompassing product cycle. Four critical processes are identified in Diagram 22 that are spaced around the circumference of the model of the political ecology of design and technology. These are normative processes in sustainable design (Petrina, 2000). Although these models are very useful for sustainable design as they can identify the interdependent relationships within technological practice they are very complex an inefficient for the purpose of this study.
Diagram 20: Political ecology: Circuit of culture model

(Petrina, 2000, p. 226)

Diagram 21: Political ecology: Conditions and processes model

Diagram 22: Political ecology: Designing critical processes model

(Petrina, 2000, p. 224 & 227)
The framing-five phases background model

Alternatively, Keirl (2009) advocated “designerly intelligence” (p. 6) through, citizenship, values and participatory democracy that accommodates a sustainable co-existence in the complexities of technology’s all-encompassing ambit. As a framework to overcome pedagogical challenges Keirl’s (2009) useful Five Phase framing involves Intention, Design, Realisation, Use, and Consequences as a way of identifying technological phenomenon and the co-dependent aspects at play. However this model is unable to identify and measure inter-relationships and subtle differences between typologies of technology practice.

Diagram 23: Framework for technological literacy through five phases

(Keirl, 2009, p. 40)
Product framework

Rutland’s framework for the study of Food Technology draws on the need for design and decision making skills. There are some similarities to Technacy Theory in that a change in any one of the five areas will affect change in one or all of the areas. Thus the framework is able to identify the interdependent relationship within technological practice for a food design. For example, the use of an ingredient—such as white flour instead of wholemeal flour—to produce more fibre in the food design (technical decision) which then affects aesthetics such as the appearance, flavour, texture and quality (Rutland, 2008, p. 307). Nevertheless, this framework is more relevant to design processes rather than having the capacity to identify and measure inter-relationships and subtle differences between typologies of technology practice.

Diagram 24: Framework for design decisions in food technology

(Rutland, 2008, p. 307)
A review of the literature around the study and form of technological knowledge suggests that the field remains essentially disaggregated; useful contracts appear, and occasional associations of durable value are proposed, but there remains little theoretical work that seeks to assert a universal and transferrable foundation to the ontology of technological knowledge itself. Some published concepts of technology align ecological and sociological elements into its form while most focus on a design process theme. A limitation of many design-oriented frames for the study of technology is that the process approach is often formulaic with little reference to the technological form of the knowledge being studied. A risk with such approaches is that while design studies may enable higher order thinking in the process of designing, very little of the same is offered to the form of technological knowledge itself. This dominant focus on design at the expense of technology studies, can introduce an element of risk with the task of technological judgement and choice.

Technacy Theory offers a way to value a proper place for both a cogent examination of technological understanding as well as the role that design plays in the educational process. One of the key ideas underpinning technacy theory is that the form it takes as an explanation of technological knowledge is that its repeats upon itself as well as links to other forms in a ‘fractal’ relationship. This proposition makes technacy theory scalable and offers a way to see how complexity may arise out of simple relationships between people, tools and ecology when they are combined to meet a purpose in an applied context setting. Furthermore, in terms of formal technology education, the diverse ways society seeks to conceptualise technology practice suggests that while we may all see intuitively some aspects of technical knowledge linking together, we equally struggle to clearly articulate it all into one whole universal model. In the context of this study, we may
compare the core concern here that many schools struggle to identify the difference between Food Technology and Hospitality, even though at some other level, links between them are recognised. Nevertheless, the two subject areas remain essentially incomprehensive as belonging to a single parent of technological knowledge. A case in point today shows in Appendix 6 the skewed perception of Food Technology positioned under a Hospitality Framework. The literature to this point shows a flawed knowledge base for Food Technology by many teachers, curriculum officers, the general public and students upon completion of their school years. This thesis asserts, through the frame of Technacy Genre Theory, a robust, universal model that makes transparent different types of technology practice and that this approach would clarify the proper labelling of subjects and teaching content. The next section develops the methodological design used for this thesis.

2.1.5.3 A conceptual framework for the study of Food Technology and innovation in schooling

Technacy Genre Theory

This section proposes an approach to the methodology. Of particular theoretical interest to this thesis was whether Technacy Genre Theory could operate empirically as a genre indexing system by detecting a high degree of precision between different types of technology genre. Technacy Genre Theory aimed to guide the direction for collecting, analysing and mixing qualitative and quantitative aspects for the various phases in the research process. The universal structure of Technacy contains an interrelated outside genre system (knowledge, tools and ingredients, materials and ecological elements) that define the purpose and context parameters and as such provides a lens to identify different types of technological practice and knowledge. The aim was to design Technacy Genre
Theory to act as an indexing instrument to measure knowledge, techniques and materials of a technology genre. The classes for this study included food technology as a science index and food hospitality as a vocational index. Therefore, the stronger the participant is in choosing food science or hospitality, the clearer the participant is about their technology genre. The weaker the participant is in choosing food science or hospitality, that is, alternates between the two, then this detects confusion about their technology genre. Science was allocated a higher score, while hospitality was allocated a low score. The genre instrument aimed to detect where a participant sits in genre. For example, a high Technacy Genre Index approaching 1.0 suggests a strong science, innovation and food design orientation; a low index approaching 0.0 suggests strong vocational, cooking-skills, conservative orientation to the purpose and practice of Food Technology.

Perception matrices were used as an adaptation from the grid method used in similar work by Provost, Martin, Hannan, Bath & Lipp (2007). This particular study was designed to discern psychology student views about the nature of human knowledge. This work drew from Sperandeo-Mineo’s earlier studies that investigated the epistemological beliefs of schoolteachers about the nature of science and the relationship beliefs they had with teaching expertise and academic background. Technacy Genre Theory was useful for designing questions and provided a frame of reference and organisational guide to gather and examine data and information from the perceptions and values between teachers and the wider profession of food technologists for food knowledge, food tools and equipment and food ingredient, material and ecological elements of food technology practice.
In the next section ontological assumptions for the research design are discussed and the methods of inquiry are presented.

### 2.2 METHODOLOGY

The purpose of methodology is to enable researchers to plan and examine critically the logic, composition and research methods; to evaluate the performance of individual techniques; and to estimate the likelihood of particular research designs that contribute to knowledge (Krippendorff, 2004, p. 21).

This section explains the method undertaken for addressing the research, and how the theoretical framework links to the main research question for this study. Methodology is not concerned about the subject matter but rather is systematic and purposeful in order to understand subject matter, or to yield data on a particular research problem (McMillan & Schumacher, 2006; Krippendorff, 2004). Choosing the appropriate method for a study is often determined by the nature of the problem (McMillan & Schumacher, 2006), and the problem at hand is one that concerns an enduring practice that was found to be common to many schools in NSW. The overarching umbrella question that addresses this research is:
To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists? Two sub questions that help answer the main research question include:

a) What is the evolution of policy and industry knowledge in Food Technology?

b) How can forms of technology practice be identified in Food Technology education?

A mixed-method design using a triangulation approach was chosen to compare historical literature with contemporary knowledge and understanding of teachers and non-teachers through a questionnaire. The validity for using both qualitative and quantitative research within the same framework incorporates the strengths of both methodologies (Johnson & Onwuegbuzie, 2004) and has been described by Creswell (2003) as the “convergence of the findings as a way to strengthen the knowledge claims of the study or explain any lack of convergence that may result” (p. 216). The basis for selecting this method allowed for pragmatic assumptions that sought improved reasoning for educational policies and arguments concerning social and human factors. The mixed method approach responded to the need for clarification across multiple issues, thereby providing a complete picture of the analysis of findings in a single study (Bergman, 2008; Brewer & Hunter, 1989; Burns, 2000; Creswell, 2003; Johnson & Onwuegbuzie, 2004; McMillan & Schumacher, 2006).

Consistent with the theoretical framework, the methodology for this research was structured around contextual and goal orientated aspects of practice through three phases:

1. Historical literature review

2. Fieldwork Scoping study (Open-ended interview questions and classroom observations)
3. Data collection and analysis (Survey instrument).

For each phase, the key elements of Technacy Genre Theory (Seemann, 2003, 2006a), human agency, tools and materials, and ecological aspects of practice were of a specific interest. This allowed for meaningful dimensions in the study to be collected in different ways and patterns identified. DeVaus (2006) points out that research should “examine and evaluate alternative ways of explaining a particular phenomenon” regardless of the design or method of collection, and that alternate ways of interpreting the findings are provisional and subject to testing. Central to arriving at an adequate understanding through multifaceted data, Bergman (2008) emphasises the importance to inform the findings, and be disciplined to the underpinning theory.
Phase 1

Historical literature review

This section was guided by the research sub-question: a) what is the evolution of policy and industry knowledge in Food Technology? Comparative measures of knowledge and technological practice aimed to define a broad description of what the minimal elements of studying food technology are—or should be—from the points of view of Demand and of Supply. The literature explored the historical, political and economic contexts of:

- Demand:
  - Understanding Food Technology as a field of study that offers unique academic attributes for school leavers and progressing study for ‘life-long and life-wide’ learning.
  - Evolution of Food Technology as an industry and as the social fabric of society.
- Supply:
  - Teacher understanding of Food Technology as a field of study that offers unique academic attributes for ‘life-wide’ learning.
  - Evolution of the Food Technology curriculum designed for NSW.
- Framework development for analysis of the demand responsiveness of the supply of Food Technology curriculum and teacher education:
  - Critical review of technology and innovation theories and attributes.
Phase 2

Stage 1: Scoping study

This approach during the early stage of the research aimed to capture a holistic and meaningful snapshot of real life occurrences between two schools from different sectors (one private and one state) on the Mid-north coast, New South Wales, Australia. Classroom observations and informal interviews were undertaken to assess staffroom culture associated with innovation tendencies, design and innovation education knowledge, and pedagogy techniques. The process involved:

- Classroom observations across years 7-12
- Informal questions and discussions with four teachers

The geographic choice of the schools for the scoping study was chosen due to the researcher’s job commitments, therefore economically more feasible for time and distance. Future study may provide more scope to pursue schools at a national level.

Stage 2: Interviews with Department Education and Training personnel and phone conversations with food industry personnel

Informal discussions with DET personnel aimed to validate issues broadly raised from the literature and that would also be guided by questions of a similar nature for the survey. From an education perspective these included discussions around the design and intent of the Food Technology syllabi from 1970 onwards, and the evolution of the 1991 NSW Design and Technology syllabus. Informal discussions with four food professionals aimed to clarify, from an industry perspective, their understanding of Food Technology curriculum in secondary schooling as a pathway for the food science and technology
profession, and the knowledge and technological practice required for post school employment opportunities in the food profession.

Both stages aimed to provide the springboard for a pilot survey instrument (in order to capture the right language) for a more representative survey sample. The survey was piloted for technical quality, readability and flow as a final design filter by three volunteers not involved in the research who closely match the age, gender and educational characteristics to the intended wider cohort of the survey. The final survey instrument was further refined to address the length of time to fill out the survey and language in response to the initial pilot of its draft.

**Phase 3**

*Data collection and analysis*

The survey instrument was essentially quantitative in nature, with qualitative responses strengthening the legitimacy of the numeric data, thus providing a more comprehensive set of data and credibility in the findings (Burns, 2000; Creswell, 2003; McMillan & Schumacher, 2006). Technacy Genre Theory guided the analysis of findings as an indexing system to detect different types of closely related technology practice, or differences in technology practice such as vocational operational skilling or science and innovation skilling.

2.2.1 Survey and Data management

2.2.1.1 Survey instrument

The questionnaire was cross-sectional in design so that a systematic investigation of relationships between two variables could be compared and to what extent two groups
differed on the outcome variable: Food Technology. Field (2009) points out that the use of one or more variables in cross-sectional work allows for associations between variables without the need to imply causality. The two groups consisted of representative people from the food profession (demand side), and the education profession (supply side). The main school system sampled was the NSW Department of Education and Training in Australia, partly because of accessibility, but also because this school system is generally regarded as one of the biggest, centralised education systems in the world (NSW Government Education Training, 2010), and so has a significant mass impact on society both in Australia and internationally.

Although the research contained a particular focus between the two groups, sub-groups containing the same characteristics (used to create the strata related to the dependant variables) were built into the research design. According to DeVaus (2002), cross-sectional or correlation design can have any number of groups, and is particularly common in order to achieve well-informed findings.

Questions were structured in a general and easy to understand language consisting of open and closed questions that were arranged across three sections in the questionnaire. This encouraged sectional completion at the participants’ discretion. Perception grids and Likert and Ranking scales were used to measure items in the instrument. These accommodated a smaller number of more general patterns to be identified and factored against answers from individual questions (Creswell, 2003). Finally, the survey included qualitative feedback (short answer) questions to allow the respondent to express their ideas more openly.
2.2.1.2 Data bias

Measuring complex human characteristics and relationships across both qualitative and quantitative paradigms requires not only a multifaceted framework for recognising and validating patterns, but also requires the researcher to be familiar with both modes of enquiry. Additionally, all researchers bring underlying assumptions to their work that influence their method of research, and for this reason, the researcher recognises that there may have been a degree of subjectivity involved in the synthesis of findings. However, contradictory findings were identified and discussed and, given the questionnaire was predominately quantitative in nature, the qualitative responses served more to strengthen the legitimacy of the descriptive numeric data. It is declared that the combination of using the triangulation mixed method design with the theoretical framework was an attempt to lessen data bias. De Vaus (2006) emphasises the need to development clear operational definitions to avoid a “self-fulfilling prophecy” that may result in a data bias.

2.2.1.3 Survey instrument indicators

The system for selecting indicators was drawn from a method by DeVaus where a “descending ladder of abstraction” (2006, p. 24) clarified abstract concepts to possible questions or indicators that could be measured. It also helped to refine the research question, determine how many indicators to use, and how to structure the questions for the questionnaire (ibid).
Diagram 27: Conceptual framework for survey instrument
2.2.1.4 Respondent profile indicators

Indicators concerning the participants’ area of expertise, gender and age ratio, and—for teachers in particular—areas qualified to teach, depict respondent profiles. An indicator for geographic location, particularly for schools, aimed to determine any correlations between age and staffroom culture. Teaching service proportion and whether the degree type or previous qualifications influenced perceptions were measured. It was also important to quantify those who were not qualified to teach Food Technology, but who often taught the subject in schools, as their view of the subject area is important for they not only offer a perception of their colleague’s work, but also their understanding of food technology systems and practice. Conversely, the undergraduates’ year level determined their knowledge level for their field of study, while postgraduate study indicators revealed research engagement and scholarship in subject discipline orientation and pursuit for further study.

2.2.1.5 Disposition and affect indicators

Participant disposition and affect indicators sought to gauge perceptions and values toward goal orientation aspects and degrees of agreement for the purpose and practice of Food Technology. This included personal philosophies, core learning attributes required for post school jobs, expectations for professional development, classroom and workplace environments, and barriers or constraints for new ways of learning. Although the study was not based on a critical analysis of NSW syllabi, the relationship between syllabus representation and interpretation at a junior level was a plausible indicator to measure syllabus continuum and teacher willingness to teach Food Technology at a senior level.
As a result, content and modes of knowledge production employed by in-practice oriented fields aimed to measure how well practice was a manifestation of theory.

Justifiably, innovation as a field of study was an appropriate indicator to further understand the link between innovation and economic trends by way of government innovation policies and reports, and participant understanding for what constitutes a ‘suite of skills’ for post school job uptake. This relationship to assessment values sought to explore the relevance of mental visualisation to enhance abstract cognition and digital creative enterprise and therefore identify barriers that may impede new ways of learning.

2.2.1.6 Technological understanding indicators

How can forms of technology practice be identified in Food Technology education? In order to answer this sub question, technological understanding indicators were guided by the key elements of Technacy Genre Theory. This approach allowed for the identification and measurement of any inter-relationships and subtle differences between typologies (genre) of technological practice. For example, the Technacy Genre Index score suggested either a strong science, innovation and food design orientation theme, or a strong vocational cooking-skills and conservative orientation theme. Of specific interest, the Technacy Genre perception matrices detected contextual and goal oriented aspects of practice, with a specific interest in knowledge of values and contemporary food science and technologies. Consequently, in the context of Food Technology, technological understandings were framed as follows:

1. The purpose of Food Technology in contemporary context of economic and lifestyle drivers;
2. Knowledge, concepts and techniques in Food Technology;
3. Tool elements for technical production systems and devices used in Food Technology;

4. Material and environmental factors including ingredients, data or ecological resources used in food technology practice.

Participant disposition and affect were correlated with the technical understanding indicators as they pertain to Technacy Genre Theory.

2.2.1.7 Survey data source and procedure

A stratified random sampling method was used to select the population from the teaching sector (supply side), referred to in the analysis of findings as the ‘Teacher Training group’, and the food profession sector (demand side), referred to in the analysis of findings as the ‘Non-Teacher Training group’. This allowed the population to be divided into sub-groups to ensure a meaningful understanding of the demographic groupings, and to confirm that a degree of precision and accuracy of questionnaire responses was obtained between teachers, academics, undergraduate and postgraduate students, and food science and technologists. To avoid a sampling error, characteristics used to create the strata related to the dependant variables (Burns, 2000; McMillan & Schumacher, 2006). Samples were then randomly drawn from each sub-group displayed below and results compared.

- Group A: Teacher Training (Food Technology)
  - Teacher, academic, undergraduate student
- Group B: Teacher Training (Areas other than Food Technology)
  - Teacher; academic; undergraduate student
- Group C: Teacher Training (General Secondary)
  - Teacher; academic; undergraduate student
• Group D: Non-Teacher Training

  o Food scientist/technologist; academic; undergraduate and postgraduate student

In order to discern particular teaching areas under the groups, the term ‘Areas other than Food Technology’ for group B was used to include participants in teaching areas such as Industrial Technology or Information and Software Technology, while the term ‘General Secondary’ for group C was used to include participants in teaching areas such as Mathematics, Science, English, History or Geography. The reason for this was to compare the perceptions and degree of agreement between the teaching collegiate groups, and how the peers of food technology teachers view the subject in schools.

The contact details for the schools were accessed from the NSW Department of Education and Training 2007 DET Directory and the online Australian Private Schools Directory. There were 10 school regions in NSW; within each region six state schools were randomly selected, and up to six private schools randomly selected (this was due to some regions containing less than six private schools). A minimum of one and a maximum of four teachers were anticipated to respond from each school.

The contact details for universities were located from the NSW University Admissions Centre book. A minimum of one and a maximum of four academics were anticipated to respond from each university contacted. A minimum of 10 and a maximum of 50 undergraduate students were anticipated to respond from each university contacted.

There were at the time of this study:

• Six universities offering higher education bachelor degrees in Technology Education, four were randomly selected and contacted. Two accepted, while the third was selected based on convenience due to the researcher’s job location.
• Ten universities offering higher education bachelor degrees in Arts, four were randomly selected and contacted. Two accepted, while the third was selected based on convenience due to the researcher’s job location.

Eight universities offering higher education degrees in Food Science Technology or Food Science Technology/ Nutrition, four were randomly selected and contacted. Two accepted.

Approximately 80 food-manufacturing companies were identified in NSW using a Google map search, ranging from small to large-scale operations. A minimum of one and a maximum of four food professionals were anticipated to respond from each food manufacturing company. In summary, the questionnaire generated 382 responses. 699 hard copy surveys were distributed to secondary teachers, higher education academics, undergraduate and postgraduate students and food professionals. 312 responded. There were 70 online responses from secondary teachers and food professionals. Table 3 shows the distribution and response rate for the survey instrument.
2.2.1.8 Survey administration

The survey administration involved a multi-mode method using both paper and electronic format. This method was used to accommodate participant response preferences. Although DeVaus (2002, p. 131) argues “mixed methods are more defensible if different modes are used for different variables rather than for different respondents”, the researcher found through many conversations across both groups during the initial contact stage that the food professionals preferred the online medium rather than e-mail; the teachers preferred paper. For the universities it was more convenient to use paper,

<table>
<thead>
<tr>
<th>Secondary Schools</th>
<th>Higher Education</th>
<th>Food Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARD COPY and ONLINE SURVEY</td>
<td>HARD COPY SURVEY</td>
<td>HARD COPY and ONLINE SURVEY</td>
</tr>
<tr>
<td>105 schools identified</td>
<td>Technology Education</td>
<td>Food Manufacturers</td>
</tr>
<tr>
<td>60 state</td>
<td>6 identified</td>
<td>80 identified (small-large scale)</td>
</tr>
<tr>
<td>45 private</td>
<td>4 contacted</td>
<td>65 contacted</td>
</tr>
<tr>
<td>65 contacted</td>
<td>3 accepted</td>
<td>20 accepted</td>
</tr>
<tr>
<td>33 state</td>
<td>143 distributed</td>
<td>40 distributed</td>
</tr>
<tr>
<td>32 private</td>
<td>95 responded</td>
<td>7 responded</td>
</tr>
<tr>
<td>26 schools accepted</td>
<td>6 Academic</td>
<td>Food professionals</td>
</tr>
<tr>
<td>21 state</td>
<td>Arts (secondary)</td>
<td>ONLINE</td>
</tr>
<tr>
<td>5 private</td>
<td>10 identified</td>
<td>70 responses</td>
</tr>
<tr>
<td>122 survey distributed</td>
<td>4 contacted</td>
<td>Food professionals</td>
</tr>
<tr>
<td>97 state</td>
<td>3 accepted</td>
<td></td>
</tr>
<tr>
<td>25 private</td>
<td>142 distributed</td>
<td></td>
</tr>
<tr>
<td>42 teacher responses</td>
<td>44 responded</td>
<td></td>
</tr>
<tr>
<td>37 state</td>
<td>1 Academic</td>
<td></td>
</tr>
<tr>
<td>5 private</td>
<td>43 Undergraduate</td>
<td></td>
</tr>
<tr>
<td>AIFST conference</td>
<td>Food Science</td>
<td></td>
</tr>
<tr>
<td>25 distributed</td>
<td>Technology/Nutrition</td>
<td></td>
</tr>
<tr>
<td>4 responses</td>
<td>8 identified</td>
<td></td>
</tr>
<tr>
<td>ONLINE</td>
<td>4 contacted</td>
<td></td>
</tr>
<tr>
<td>6 responses</td>
<td>2 accepted</td>
<td></td>
</tr>
<tr>
<td>6 private</td>
<td>137 distributed</td>
<td></td>
</tr>
<tr>
<td>TOTAL: 52</td>
<td>114 responded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Academic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>105 Undergraduate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 Postgraduate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL: 253</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL: 77</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Survey distribution and responses
and as a result these were administered in person by the researcher. Most food professionals commented that an online medium was preferred because they felt they had enough “paperwork” to fill in on the job, while others felt paper was easier to read and navigate. Key reasons noted by many teachers with regard to an online survey were a lack of time on the job largely due to student interruptions during non-teaching periods and computer availability in the staff room. Teachers were more likely to finish the survey gradually or take it home to fill out (home being where they had more time and fewer interruptions).

It was quite clear two different forms of identical questionnaires were required to ensure an adequate population was captured. Key considerations included, the design across both methodologies needed to be exactly the same to avoid empirically skewed results; the population needed to be clearly defined, randomised questions needed to be included to reduce order bias, and technological preferences catered for to lessen non-responses. Both methods contained strengths and weaknesses therefore validation phone calls were necessary given the nature and complexity of this topic and the length of the questionnaire. This process not only aimed to clarify any questions or misunderstanding of the questionnaire and ensure respondents completed the questionnaire (paper or online), but more importantly increase the methodological rigor for the research (Bergman, 2008).

Although it was beyond the scope of this research to undertake an exhaustive literature search into the psychometric characteristics for two survey methodologies, scholars validate both online and paper questionnaires are facile and capable options (Basnov, Kongsved, Bech & Hjollund, 2009; Dolnicar, Laesser & Matus, 2009; Gordon & McNew, 2008; Lonsdale, Hodge & Rose, 2006; Mertler, 2003; Ritter, Lorig, Laurnet, & Matthews, 2004). Their reasoning is that: 1) they both produce equivalent reliability and
internal consistency provided the survey format is exactly the same; 2) that there are randomised questions included to reduce bias; and 3) that participants are clearly defined, and “each member of a population has the same a priori probability to participate in either an online or mail survey” (Dolnicar, et al., 2009, p. 6). Although Lonsdale et al (2006, p. 100) point out a few smaller studies had “recorded small, yet statistically significant, differences in mean scores and reliability coefficients”, they regarded these as “non-systematic” and argue that the majority of studies suggested participant responses produced similar mean scores which outweighed any subtle differences.

Food manufacturing businesses were contacted by telephone to establish food professional’s in-principle willingness to participate. Although, for the packages containing information letters, consent forms, surveys and reply paid envelopes that were mailed to those who expressed hard copy preferences, the response rate was poor. Validation phone calls revealed some participants did not have time and had changed their mind about the research, while others noted that in reflection they would rather engage in the research using an electronic format. The Australian Institute Food Science Technology Incorporated was contacted to explore the possibilities for reaching food professionals through an electronic medium such as e-mail. Due to privacy laws, this was not possible. However, the AIFST expressed strong interest in the research and an online survey was replicated from the hard copy version and uploaded to the AIFTS main page website. The Executive Manager also distributed hard copy surveys at a Science Teacher conference in Tasmania and as a result the research transferred as a national interest.

Once the schools were selected, Principals were contacted by telephone first to establish an in-principle willingness to participate and preferred mode (i.e. paper or online). Upon consent a package containing information letters, consent forms, surveys and reply paid envelopes was mailed to the Principal and the Head Teachers for both TAS and Non-TAS
faculties. Follow up phone calls were undertaken to gauge survey acceptance and distribution to participants.

Once the universities were identified, academics were first contacted by telephone to establish an in-principle willingness to participate and preferred mode of participation (paper or online). Although packages were mailed to the academics containing the information letter, consent form, surveys and reply paid envelopes, and validation phone calls revealed some had not had time to distribute the surveys. As a result the researcher personally visited three of the universities, and, in a forum environment, the students were explained the nature of the research, provided with the Information Letter and invited to participate. Those who were interested were then provided with the questionnaire to fill out. The researcher remained present for the first 10 minutes in order to clarify any questions or misunderstanding the survey may have presented, particularly for international students. The surveys were collected by an external agent not related to the study, such as administrative personnel, and put into sealed boxes for the researcher to collect. This process was replicated for the university the researcher was employed at.

2.2.1.9 Reliability and validity

Criterion validity methods were not suited to this study due to a lack of survey precedence in this field of study. A wide range of questions of relative importance to each other, were crosschecked against each other to avoid epistemological assumptions and to enhance content validity. This triangulation approach allowed for cross-validation among data sources, data collection strategies, time periods and theoretical schemes. Reliability was measured as specific inferences to theoretical expectations through factor analysis. The inter-correlations of item responses for the Likert scales, for example, demonstrated homogeneity (Burns, 2000; De Vaus, 2006; McMillan & Schumacher, 2006).
Participants were required to choose ten items in a perception grid from each question with regard to their technological understanding for Food Technology knowledge and techniques, tools and equipment and materials and ingredients (K&T question 1201-25; T&E question 1301-25 and M&I question 1401-25). A three-way correlation matrix (drawing on Technacy Genre labels) was used to identify knowledge and techniques, tools and equipment, and materials and ingredients between groups. This was used to validate technological understandings for Food Technology in both Food as an Area of Study (FAOS question 1501-1514) — a Likert Scale containing fourteen questions for degrees of agreement for the purpose and practice of Food Technology using a Technacy Genre Index scoring system—and Food as a Scholarly Choice (FASC question 24), which requested participants to rank Food Technology in order of preference as a scholarly choice. It was hypothesised that two different forms of Technacy Genre practice would be evident: food science and vocational operational skilling. The stronger participants were in choosing either of the two, the more determined the clarity of their technology genre. Weaker scores detected confusion. Section 3 was structured in the same manner as Section 2 (that is a perception grid, Likert scales and ranking scales), were validated using the same methods as above for questions around innovation and assessment. Qualitative responses were analysed using Technacy Genre Theory and factored against the quantitative results. It was hypothesised that similar technological understandings for knowledge, equipment and materials would match up with the quantitative responses.
2.2.1.10 Respondent bias

Creswell (2003) warns that non-responses may potentially change the overall results and as a measure to eliminate bias all survey responses were coded individually for confidentiality; where necessary, validation phone calls were made to clarify non-responses and to find out if these differed from other responses. Where attrition rates were strong enough in the qualitative responses to affect validity, these were compared with other variables (De Vaus, 2006).

2.2.1.11 Acquiescent responses

Questions were designed to avoid participants overtly agreeing with statements, particularly if they were unsure about a question, or tired, or perhaps losing interest. To avoid a central tendency in Likert Scales—where ‘agree’ and ‘disagree’ were unavoidable indicators—‘neutral’ or ‘don’t know’, were not included. The style of the Likert Scales varied to accommodate visual interest. De Vaus (2002, p. 107) advised to restrict the agree-disagree format and provide “reversed-keyed type questions” that heighten participant awareness and maintain interest momentum. For example, FAOS (question 1501) and FAOS (question 1503)—these questions requested participants to decide whether students chose to study Food Technology because the subject offered a relevant pathway into hospitality or as a career in food science. Questions that focused on the participants personal experience, such as Expectations and Experiences (EE question 2201-2210), were placed in the middle of the survey, while a question called a Brain Bender was placed last to encourage creative input as a way to verbalise their perceptions from the ‘coal face’ of the teaching or industry sector.
2.2.1.12 Missing data and data manipulation

De Vaus (2006, p. 150) recommends the use of a “random assignment within groups” method, where genuine missing data is evident. Where appropriate, the same value from the nearest preceding case was allocated to the case with the missing value for that group. According to De Vaus, although a complex procedure, randomly assigning missing values does not affect the sample or group variability.

The survey instrument enabled returns to be grouped into two and four sets, based on answers to the initial categorical questions of the survey. Accordingly, the initial tests undertaken sought to compare question answers by groups. The survey also included several key questions where within and between questions it aimed to reveal respondent orientations based on such things as associations to different domains of professional practice and tools teachers identify with most.

The qualitative questions were analysed for thematic content framed by their purpose and contextual factors. Technacy Genre headings were structured in a table format (Human agency, Tool, Material and Ecological elements of practice) with sub-headings relevant to the question. Ideally these were sought, but using an open-ended strategy ensured the genuine answer was given rather than a pre-determined response guided by the question. Technacy has the ability to support alternative concepts as subsets within the framework as it is a nested system (Seemann, 2011), which, in this case, are the responses. Science and VET patterns were highlighted using red and blue coloured makers then collated into an excel spreadsheet. An example for Question 21 is presented in Table 4. The purpose of the question was that of a high level philosophical one with professional development as the context. The table was structured thus:
**Context:** Do you feel that you have sufficient access to professional development?

a) If yes, how often would you update your knowledge and skills from a food science and technologist workshop?

b) If no, state what type of professional development you would like to receive.

**Purpose:** Type of professional support for improving teacher quality—professional industry practice—generic aspirations if any

<table>
<thead>
<tr>
<th>Survey id</th>
<th>Human Agency Science/VET &gt;Knowledge &gt;Values &gt;Career aspirations</th>
<th>Tools Science/VET &gt;Cooking utensils &gt;Laboratory equipment</th>
<th>Materials/Ingredients Science/VET Ecology &gt;Cooking recipes &gt;Laboratory experiments &gt;Sustainable food chain</th>
</tr>
</thead>
</table>

**Table 4: Qualitative organisation for analysis of findings**

This provided an avenue to assess whether an unprompted balanced view for technical and ecological aspects—as they pertain to Technacy Genre Theory—were evident. An Excel spreadsheet was used to input data ready for quantitative analysis into a Predictive Analytics Software Statistics (PASWS) program. PASWS was used to explore the data for trends, patterns, and relevant associations between groups of respondents across a range of tests, using descriptive techniques to describe the strengths of data patterns.

Non-parametric tools for categorical data used Chi-square and descriptive tools, including visual presentations (Frequency Table report with graphs) of the data to aid the exploration process. Dependent t-tests were also used to identify demographic information between the two groups; for example, age, gender and age, teaching or working years, employment type.

Where data confirmed to parametric conditions, a two-sample t-test was applied. For
example, an independent t-test was used for the Likert scales and Ranking scales where science and VET mean scores were compared between two groups. A Sheffe Test was also applied to identify the differences between two groups (teacher training and non-teacher training) and four groups (Teacher training: Food Technology; Teacher training: Areas other than Food Technology; Teacher training: Secondary teachers; Non-teacher training: Food scientist technologist).

Where data compared multiple variables, factor analysis, correlation and regression methods were used. For example, using one-way ANOVA, Pearson’s Correlation was used for the perception matrices in questions 12, 13 and 14 to test the strength of the relationship between the two groups: Teacher training and non-Teacher training. There were three matrix tables containing the three technacy elements as headings: 1) Knowledge and techniques; 2) Tools and equipment; and 3) Materials and ingredients. Each matrix contained twenty-five words and phrasing that were either science or VET focused. These were evenly distributed, with the odd number remaining used as a common word or phrase for both science and VET to accommodate any overlap. Ten words or phrases were required to be circled that best described the participant’s perception, for example, of knowledge and techniques required in Food Technology. A single index number was created per survey respondent. Science based responses were added up then divided by ten. If a participant circled ten out ten, a perfect science perception of 1.0 was achieved. If a participant circled five science perception answers then the score would be 0.5 and if one science wording were circled then a very low score for science would be 0.1. The scores were then collated into PASWS, where a Scatter plot was produced and simultaneously R tested. Technacy theory states that the three very specific variables mutually co-relate; they are co-dependent in a necessary three-way relationship so, according to the theory, if one Technacy element did not correlate then this
would weaken the Technacy Genre assertion. If all three correlate then there is a strong correlation that is statistically significant in a positive linear way.

Conventional standards were used for the reporting of statistical tests where the significance level was stated ($\alpha$), and degrees of freedom (df), probability value ($\rho$ or .sig) and type of test (T-Test-$t$: ANOVA-$F$ or Correlation-$N$) declared. Where a statistic was declared as significant, ($\rho$) was less than or equal to ($\alpha$). The next section presents the data findings from the study.
CHAPTER 3: ANALYSIS OF FINDINGS

3.1 TEACHER TRAINING IN FOOD TECHNOLOGY

This is a good point to insert a caution that needs to accompany every survey that is taken and reported. Surveys are not about fact; they are, instead, about what people think. A survey is about public reactions, what the public thinks, and what it is prepared to support and not support. It is also a snapshot taken in time. Opinions can and do change as events take place as new ideas and understandings come forth (Rose, et al., 2004).

The aim of the study was to provide a snapshot between the outside worldview of food technologist perceptions to the inside school view of secondary food teacher perceptions for what is meant by the label ‘Food Technology’ and its practical manifestation. The survey instrument collected information that sought to establish contemporary perceptions about the study of Food Technology in Australia and the role secondary education may play in ‘supplying’ people for professional studies towards a career as a food technologist. In this arrangement, the industry and profession of food technologists represent the ‘demand’ side of the process that starts with receiving students ‘supplied’ by the schools sector into undergraduate food science and technology courses. The key question this study sought to clarify was: To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists?

The qualitative and quantitative critical analysis of the two contexts sought to identify the perceptions, values, and technological understandings of food technology, sources, production and consumption. The study was not based on a critical analysis of NSW Food Technology syllabi, although syllabi are referred to where responses or comment are
relevant. Guided by Technacy Genre Theory, perceptions were gathered around contextual and goal oriented aspects of practice, with a specific interest in:

1. Human elements (agency, knowledge, techniques, values, social organisation)
2. Tool elements (e.g. enabling technical devices and systems)
3. Material or ecological elements (e.g. consumable ingredients, properties, aesthetics, impact on ecology).

Technacy Genre Theory identified differences between typologies of technology practice for Food Technology. The Technacy Genre Index developed did in fact detect a high degree of precision between two genres: Food Technology as a science and Food Technology as hospitality, under the one label of Food Technology. The indexing system was able to demonstrate both:

- The existence of Technacy Genre [the existence of technology types by the comparative measures of the Technacy Genre perception index]; and
- Genre identification that clarified a long-standing problem in the context of Food Technology in schools, relative to the wider professional expectation of the same.

The study also gauged relative attention given to goals concerning sustainability, economic trends, and innovation capacity building, as these areas remain topical in the wider context of the field of food technology research and emerging world concerns. In understanding these dynamics, the framework identified meta-inferences to suggest both groups did not perceive sustainability as an important connection with food technology, but there were different perceptions between groups relative to economic trends and innovation.
3.2 THE TEACHING OF FOOD TECHNOLOGY AND INNOVATION IN SCHOOLS

The data from the study is presented in three parts as they pertained to the design of the survey: 1) Demographics, 2) Food Technology and General Education, and 3) Innovation, Food Technology and Technology Education. This section briefly explains the design of the questionnaire followed by the analysis of findings.

Demographics

The sample size was divided into two groups: The food technology profession presented as the reference group – this data was colour coded in red. The teachers presented as the comparative group – this data was colour coded in blue. The analysis of findings refer to participants as ‘Teacher Training’ and ‘Non-Teacher Training’ or ‘secondary food teachers’ and the ‘wider professional group of food technologists’, used interchangeably; while ‘food profession’ is used interchangeably with ‘Food Scientist Technologist’, ‘wider professional group’, and/or ‘wider community of Food Technologists’.

The two groups were further split into four groups to allow for a more detailed comparison and where more emphasis was required, these were colour coded accordingly as follows:

- Group A: Teacher Training (Food Technology) – Blue
- Group B: Teacher Training (Areas other than Food Technology) – Mauve
- Group C: Teacher Training (General Secondary) – Green
- Group D: Non-Teacher Training (Wider food profession) – Red
The demographic profiles examined the participant’s:

- Area of expertise
- State of employment
- Gender
- Age
- Teaching or working years
- Employment type
- Qualifications and educational background
- Areas of teaching qualified to teach and areas taught but not qualified to teach
- Undergraduate year level and postgraduate study.

**Food Technology and General Education**

This section sought to identify academic culture for knowledge and techniques, tools and equipment, and materials and ingredients (inclusive of ecology) for the teaching of Food Technology. Food Technology as an area of study and scholarly choice aimed to identify why it was important to study food technology and the value placed on the subject in the curriculum. The study was also interested in various technologies that may support the teaching and learning or practice for Food Technology and what type of professional development the participants sought and what knowledge sources they drew from to inform their practice.

**Innovation, Food Technology and Technology Education**

In this section participant perceptions and values for intellectual capital were identified, and to what degree there is a culture of continuous innovation through design, technology and food science based education. This section is largely based on government reports and

3.2.1 Demographics

**Area of expertise**

The population in Figure 5 represented participants from two main groups: Teacher Training and Non-Teacher Training (both n=191). The Non-Teacher training group was present as the reference group, while the Teacher Training group was present as the comparative group. These were collated into four different subgroups (Figure 6):

A) Teacher Training: Food Technology (n=78);

B) Teacher Training: Areas other than Food Technology (n=58);

C) Teacher Training: General Secondary (n=55) and

D) Non-Teacher Training: Food Profession, such as members of the Australian Institute of Food Science and Technology Inc. (n=191).

Participant types for each subgroup were identified under categories as: Undergraduate student, Postgraduate student, Teacher, Academic, or Food Scientist Technologist (Figure 7).
Figure 5: Participant groups

Figure 6: Teacher Training and Non-Teacher Training groups

Figure 7: Individual group types
Employment by state

NSW has the largest education system and biggest population and therefore dominates both at State and National levels (Figures 8 and 9). The Non-Teacher Training group represent science and innovation from an Australian professional view nationally and reflects the universities the research was carried out for in this study. This group also has a high proportion of International students inclusive of NSW. These students offer an insight from an International perspective for the field of study (n=191). The Teacher Training group also displays a large portion of teachers and undergraduate students.

Figure 8: Teacher Training by state

Figure 9: Non-Teacher Training by state
Age

Both groups display a similar age distribution in Figure 10, therefore the interpretation of responses are comparative as to whether age influences particular perceptions about Food Technology as a subject area (n=382). A bi-modal figure exists between 30-49 years for the Teacher training group. This suggests that the teaching profession has a strong middle age continuum. Although a sharp rise for 20-29 years for the teaching group is consistent with the university undergraduates who participated in this study, it signifies a new cycle in the teaching profession (n=191, mean=30-39 years, median=32 years, SD=1.652). A same sharp rise is evident for the Non-Teacher Training 20-29 year age group, which also signifies a new cycle in the food industry profession. This group includes an influx in international students. The age spread between 30-59 years for the teacher training group shows a steady middle age, but lower continuum for the food industry (n=191, mean=20-29 years, median=20-29 years, SD=1.257).

![Age Grouping](image)

*Figure 10: Participant age group*
Gender and age

Figures 11 and 12 present a dominant female gender grouping across both groups (Teacher Training n=116 and Non-Teacher Training n=141), particularly for 20-29 years of age. A higher male grouping spread is evident across the Teacher Training group, particularly for the 30-39 years of age (n=75) compared to the Non-Teacher Training group (n=50). This gender in-balance may influence particular perceptions about Food Technology as a subject area.

Figure 11: Teacher Training age and gender

Figure 12: Non-Teacher Training age and gender
Teaching or working years

Undergraduate students were not included in this question given they had not worked professionally in their chosen field (n=241). Both group display multimodal data sets in Figure 13 for length of service. A bi-model figure for 5-10 years and 26-30 years presents a similar pattern between both groups. The data suggests a twenty-year cycle revival into both the teaching profession and the food profession. Bi-modal figures of 21-25 years and 31-35 years for the Teacher Training group suggest a fifteen-year generational decline in teachers entering or staying in the profession, with retirement years being taken up after a 30-year period. The Non-Teacher training group present bi-model figures between 11-15 years and 26-30 years that suggest a 20-year cycle revival, then again between 11-15 years and 36+ years. This suggests a 5-year generational gap of industry employees, and may be associated with job opportunities nationally. The graph also suggests food technologists remained employed longer than teachers (Teacher Training: n=53, mean=16-20yrs, median=20-21 yrs, SD=1.938; Non-Teacher Training group: n=78, mean=16-20 years, median=20-21 years, SD=2.282).

Figure 13: Length of working years
Employment type

In the case for both groups, Figure 14 displays the majority of participants were in full time employment (Teacher Training group 85.5% and Non-Teacher Training group 92.4%). The nature of the respondents’ full-time employment brings practicing currency and an experienced view to the survey (n=141). Undergraduate students were not included in this question given they had not worked professionally in their chosen field (n=241).

![Employment Type Diagram](image)

**Figure 14: Employment type**

**Completed or enrolled in a full degree\(^6\) and degree name**

Sixty-one degree types containing various specialisations were recorded (Figures 15 and 16). These were categorised broadly into the Humanities and the Sciences. This question sought to frame whether the type of educational background influences particular perceptions about Food Technology as a subject area (n=371).

\(^6\) Normally a 3-4 year degree.
Disciplines were grouped into common themes representing areas of study for the Humanities in red (Teacher Training) and the Sciences in blue (Non-Teacher Training).

Figures 17 present two contrasting themes and which signify implications for the study of Food Technology given the opposing disciplines for the educational background of participants. It is this contrast in disciplines that may help explain the differing perceptions
between both sectors for what constitutes the study of Food Technology. (Teacher Training group n=180). (Non-teacher Training group n=191).

Figure 17: Disciplines areas

**TAFE/university combined qualification with a food technology focus**

A very small proportion of participants had undertaken a TAFE–University combined qualification. These included two participants with a Food Certificate qualification, one a Teaching Certificate qualification, and one participant having completed an Accelerated Teacher program (n=4).

**4 year technology education degree with a food major**

Although a larger proportion of participants with no Food major presents for the Teacher Training group (Figure 18), it is important to highlight that those who are not trained in Food Technology often teach Food Technology in schools. Their view of the subject area is important as they offer a perception of their colleague’s work (n=191). Figure 19

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7 May be called D&T, BTechEd or TAS with ‘NO’ TAFE embedded training.
presents Humanities-based degrees predominate in education, while Figure 20 presents science-based degrees predominate in the food profession. The comparison of study between the humanities and the sciences offered a springboard upon which to understand and explain the different perceptions held by both groups.

Figure 18: Teacher Training food major

Figure 19: Teacher Training food major name

Figure 20: Non-Teacher Training food major

Figure 21: Non-Teacher Training food major name
Knowledge of lecturer’s qualification if studying under a Food technology related university degree\textsuperscript{8}

Figure 22 shows the Teacher Training group demonstrates a weak interest in the qualification of their lecturer’s discipline compared to the Non-Teacher Training group. This suggests the culture of teachers may have a diminished view for discipline content importance.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{lecturers_qualification}
\caption{Known lecturer qualification}
\end{figure}

Undergraduate student’s year level

Figure 23 presents a similar profile for undergraduate students’ experienced study in the subject. In particular, the third-year year students predominate for both groups, so it is assumed they should know the subject well in their respective field (n=198).

\textsuperscript{8} If yes, note area of expertise.
**Figure 23: Undergraduate student year level**

**VET or university background for undergraduate students**

The Teacher Training group presents a higher VET background compared to the food profession (Figure 24). It is this strong identity for vocational operational skills that changes the perception of the subject matter, and where some language may be closely aligned, however with the practice being different (n=53).

**Figure 24: Background education**
**Original qualification prior to TAS teaching qualification**

Figure 25 shows that a high proportion of participants were qualified in Hospitality prior to entering study for the teaching profession. This supports the trend of the articulated pathway from TAFE to university for hospitality, and fast-tracked pathways for mature age students with a trade in hospitality (n=36).

![Figure 25: TAS Teachers: Prior qualifications](image)

**TAS qualification educated to teach**

Although this question sought to locate two main areas that participants were qualified to teach in, many responded with multiple answers. The top two results in Figure 26 show predominately gender response groupings, as they are favoured teaching areas commonly taught in schools. For example, Food Technology, Textiles and Hospitality are common female teaching subjects, while Industrial Technology, Metal, Engineering, Construction and Graphics are common male teaching subjects. A small proportion noted only one area.

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9 This question was posed only to Technological and Applied Studies (TAS) teachers.
10 This question was posed only to Technological and Applied Studies (TAS) teachers.
of teaching, even though they may be qualified to teach in other areas under the TAS stream. This suggests a resistance to teach outside of their area of expertise (n=55).

![TAS Area Qualified to Teach](image)

**Figure 26: TAS Teachers: Subject areas qualified to teach**

*Teaching areas taught not formally educated in*¹¹

Figure 27 shows that there is an emphasis for TAS teachers to teach in the Family Studies and Early Childhood subjects that traditionally has had a strong relationship with cooking and sewing skills. This reinforces a vocational and soft subject view concerning teacher capabilities in TAS (n=24).

¹¹ This question was posed only to Technological and Applied Studies (TAS) teachers.
Figure 27: TAS Teachers: Subjects taught without a formal qualification

Original qualification prior to Non-TAS teaching qualification\textsuperscript{12}

A poor response rate was evident for this question, which could be due to misinterpretation given the assumption most participants would have had a first degree. Each participant each had prior qualifications in Visual Art and Music, with two participants in administration (n=4).

Non-TAS qualification educated to teach\textsuperscript{13}

A larger proportion of non-TAS teachers were qualified to teach science (Figure 28). This may be a factor as to why this group interpreted the Technacy Genre questions as science-based. Visual Art also presents strongly and may be due to competitive employment positions in this field (n=25).

\textsuperscript{12} This question was posed only to Non-Technological and Applied Studies (Non-TAS) teachers.
\textsuperscript{13} This question was posed only to Non-Technological and Applied Studies (Non-TAS) teachers.
Figure 28: Non-TAS Teachers: Subject areas qualified to teach

Teaching areas taught not formally educated in

The participants for this group were largely students and had not engaged in teaching as a profession. For those that did respond, one participant each were identified as teaching in an area they did not have formal qualifications to teach in, such as Computer Applications/Graphics; Software Development/Textiles; Engineering Science; Agriculture; Textiles and Graphics (n=6).

Postgraduate study undertaken

Figure 29 shows that innovation and research does not emerge as a strong pattern for post teacher training (n=12). Where the non-teacher training group present as strongly engaged in research and scholarship in subject discipline orientation and pursuit for further study in Figure 34 (n=46), the teacher-training group present as minimal to non-existent. The data is projecting that the school culture is not engaging or evolving in their discipline areas

14 This question was posed only to Non-Technological and Applied Studies (Non-TAS) teachers
and, because of this lack of research capacity, this reinforces their own socially constructed view. Figure 29 shows that innovation and research does not emerge as a strong pattern for post teacher training (n=12). Where the non-teacher training group present as strongly engaged in research and scholarship in subject discipline orientation and pursuit for further study in Figure 34 (n=46), the teacher-training group present as minimal to non-existent. The data is projecting that the school culture is not engaging or evolving in their discipline areas and, because of this lack of research capacity, this reinforces their own socially constructed view.

**Figure 29: Postgraduate study**
3.2.2 Food Technology and General Education

Participants were asked to circle phrases or terms in three perception grids that sought to identify and clarify the degree of technology genre agreement between the two groups:

1. Teacher Training
2. Non Teacher Training

And between the four groups:

1. Teacher Training: Food Technology
2. Teacher Training: Areas other than Food Technology
3. Teacher Training: General Secondary and
4. Non Teacher Training: Food Profession

The research framework draws on Technacy Genre Theory (Seemann, 2003), which offers a way of identifying and measuring degrees of agreement between typologies of technology practice. The genre framework is designed to detect inter-relationships and subtle differences between combinations of materials, tools and techniques to include:

- Human factors (e.g. knowledge, techniques, values, social organisation)
- Tool factors (e.g. technical inputs and output - device systems)
- Material factors (e.g. ingredients, data or ecological resource factors - properties, aesthetics, impact on ecology).
**Knowledge and techniques used in food technology**\(^{15}\)

The research found that teachers perceived priority systems of Food Technology knowledge significantly differently to the wider professional community of food technologists in Figure 30. Knowledge: Teacher index= 0.31 vs. Technologists Index= 0.81 (both n=191, t=-23.614, df=380, p<.000, 2-tailed). Teacher Training: General secondary index=.37 (n=55); Food teacher index=.32 (n=78); Areas other than food technology index=.26). Non-Teacher Training: Food Scientist Technologist index=.81 (n=191); df=3, F=191.774, sig.<.000).

![Figure 30: Priority systems for Food Technology knowledge](image)

**Tools and equipment used in food technology**

Teachers perceived priority systems of Food Technology tools significantly differently to the wider professional community of Food Technologists in Figure 31. Tools: Teacher

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\(^{15}\) A high Technacy Genre Index approaching 1.0 suggests a strong science, innovation and food design orientation; a low index approaching 0.0 suggests strong vocational, cooking-skills, conservative orientation to the purpose and practice of Food Technology. Alpha = 0.05, n=382.
index= 0.21 vs. Technologists Index= 0.82 (both n=191, t=-28.284, df=380, p<.000, 2-tailed). Teacher Training: General secondary index=.29 (n=55); Food teacher index=.20 (n=78); Areas other than food technology index=.15 (n=58). Non-Teacher Training: Food Scientist Technologist index=.82 (n=191); (df=3, F=297.008, sig.<.000).

Figure 31: Priority systems for Food Technology tools and equipment

Materials and ingredients used in food technology

Teachers perceived priority systems of Food Technology ingredients and materials significantly differently to the wider professional community of food technologists in Figure 32. Ingredients: Teacher index=.15 vs. Technologists Index=.65 (both n=191, t=-18.947, df=380, p<.000, 2-tailed). Teacher Training: General secondary index=.21 (n=55); Food teacher index=.14 (n=78); Areas other than food technology index=.11 (n=58). Non-Teacher Training: Food Scientist Technologist index=.65 (n=191); (df=3, F=297.008, sig.<.000).

An unexpected result showed that, despite the sub-group of general secondary teachers with no training in either Food Technology or any other technology field, their overall Technacy Genre index shows better agreement with the genre practiced by the food
profession compared with food technology teachers and teachers who teach in areas other than Food Technology in schools: For Knowledge: Secondary teachers index=.37, Food teachers index=.32, Food Technologist index=.81; For Tools: General secondary index=.29, Food Teachers index=.20, Food Technologist index=.82; For Materials and Ingredients: Secondary teachers index=0.21, Food Teachers index=0.14, Food Technologist index=0.65. On all measures, food teachers and ‘other field’ technology trained teachers scored the lowest in their perceptions of what Food Technology education entails compared to the rest. This poses a significant problem for the food profession for how food technology is portrayed in schools: Knowledge index=0.26, Tools index=0.15, Materials index=0.11.

Figure 32: Priority systems for Food Technology materials and ingredients

Technancy correlation for knowledge, tools and materials

On the issue of evidence for coherence in genre co-relationships existing between food knowledge, techniques, ingredients and tools (Figure 33), the results of a Pearson’s 3x3 correlation matrix shows there is a very strong three-way interdependent pattern, as predicted in Technancy Genre theory. Knowledge-Tools (n=382, r=.823, p<0.000, 2-
Food technology as an area of study

A Likert Scale of twelve questions asked respondents for degrees of agreement for the purpose and practice of Food Technology as an area of study. A Technacy Genre index score of 4-5 for six of the questions suggests a strong science, innovation and food design orientation theme, with the other six questions suggesting a strong vocational cooking-skills and conservative orientation theme (1-3). One independent question sought to clarify whether schools offered Food Technology for the senior years with a view to detect teacher willingness to teach the subject. Alpha=.05, n=325. In summary the questions included:

- Depth and breadth of sourced literature
- Creative enterprise through visualisation and mental imagery
• Food Technology syllabus representation and educator interpretation
• Food Technology as a valued and scholarly subject area in education
• Perceived practical learning activities for the study of Food Technology
• Educator technology genre values and willingness to promote/teach the subject.

The research found that teachers perceived the educational value of Food Technology as substantially and significantly different to the food profession. Figures 34 and 35 suggest the food technology teachers perceive the subject as VET based. The data suggests some contradictions amongst the teachers who teach in areas other than food technology for where the subject is sitting currently and where the subject needs to go. The food technologists appear to be very clear the subject is science-based or should be. For science: Food technologist index=3.31 (n=157); Areas other than food technology index=3.27 (n=42); Food Teacher index=2.80 (n=69); General secondary index=2.72 (n=47); (df=3, F=5.709, p<.001). For VET: General secondary index=3.39 (n=48); Food teacher index=3.23 (n=75); Areas other than food technology index=2.84 (n=48). Non-Teacher Training: Food technologist index=2.29 (n=154); (df=3, F=18.908, p<.000).

![Figure 34: Teacher Training and Non-Teacher Training science index](image-url)
General secondary teachers in particular appeared to view the subject as offering a relevant pathway into hospitality compared to the food profession (Figure 36). This further pushes the vocational operational skills theme that poses a significant problem for the wider profession of food technologists. Teacher Training: General secondary index=4.32 (n=47); Areas other than Food Technology index=4.02 (n=41); Food teacher index=3.75 (n=64). Non-Teacher Training: Food scientist technologist index=3.31 (n=114); (df=3, F=13.926, sig=.000).
Figure 37 shows that the teacher view dominates toward end-user cooking skills as learning for self-sustainable life skills. This suggests the NSW Food Technology 7-10 syllabus does not provide an adequate lead into the senior Food Technology syllabus as well as what it was designed to do, or perhaps that teachers are misinterpreting the syllabus. Teacher Training: General secondary index=4.25 (n=48); Food teacher index=4.09 (n=68); Areas other than Food Technology index=4.00 (n=48). Non-Teacher Training: Food scientist technologist index=3.06 (n=125); (df=3, F=25.061, sig.=.000).

**Figure 37: Food Technology focuses on practical cooking skills**

The following data did not show significant responses at alpha set to .05, but it does show a trend towards alpha consistent in theme with the significant data presented thus far. A pattern of responses shown in Figure 38 suggests that Food Technology is not greatly supported by food teachers as much as it could be. Again, this trend aligns with current 2009 and 2010 archived statistics from the NSW Board of Studies previously stated, and one that reinforces the vocational operational skills theme rather than nurture student interest in food science. Personal communication with O’Connor (June 9, 2006), as secondary school teacher connected to the scoping stage of this research, revealed “students do not take up the subject because they see it as a job pathway to become a food
technologist. If students take the subject, it is because of their interest to be a nutritionist or dietician… the syllabus is too theory laden and students preferred to take Hospitality instead because it is easier”. This may offer additional insight but does not offer a reason for the data results. Teacher Training: Areas other than Food Technology index=3.48 (n=33); General secondary index=3.41 (n=37); Food teacher index=2.96 (n=54). Non-Teacher Training: Food scientist technologist index=3.32; (df=3, F=1.655, sig=.177).

Figure 38: Food Technology offers a pathway as a food technologist

A marginally significant response rate was evident in Figure 39. Teacher Training (n=122, Teacher index=3.81) vs. Non-Teacher Training (n=113, Food Technologist index=3.52); (df=233, t=2.063, p<.040, 2-tailed). An unexpected result revealed that the food teachers and food profession possibly undervalue this area and is perhaps more ‘mainstream’ market driven (Figure 39). The data suggests that carbon footprint transparency could be better utilised with regard to technological actions and perhaps should be given more importance in teaching and learning, and food processing/manufacturing industries. Teacher Training: Areas other than food index=4.06 (n=34); General secondary index=3.91 (n=33); Food teacher index=3.60 (n=55). Food Technologist Training: Food technologists index=3.52 (n=113); (df=3, F=2.848, p<.038).
Controlled research and hypothesis testing showed no statistical significance at alpha set to .05, but shows a trend towards alpha consistent in theme with the significant data presented accordingly. Food Technology curriculum in its current format in secondary schooling does not accommodate controlled research and hypothesis testing (Figure 40). Teacher Training: Areas other than Food Technology index=2.83 (n=30); General secondary index=2.75, (n=36); Food teacher index=2.72 (n=58). Non-Teacher Training: Food technologist index=2.56 (n=122); (df=3, F=.601, sig=.615).

Figure 39: Core areas of study associated under food innovation

Figure 40: Controlled research relevance for Food Technology
Whether students choose to study food technology in years 11 and 12 in NSW is a decision largely driven by syllabus representation and teacher interpretation, teacher popularity and their willingness to teach the subject. The data did not show significant responses at alpha set to .05, which suggests post schooling pathway confusion (Figure 41). Teacher Training (n=54, Teacher index=2.96) vs. Non-Teacher Training (n=122, Food Technologist index=3.32); (df=174, t=-1.819, sig=.071). Teacher Training: General secondary index=3.84 (n=19); Food teacher index=3.51 (n=53); Areas other than Food Technology index=3.37 (n=30). Non-Teacher Training: Food technologist index=3.07 (n=68); (df=3, F=1.851, sig=.140).

Figure 41: Students choose to take Food Technology in years 11 and 12

Associated school syllabus textbooks and magazines were seen to be more useful than journals for the study of Food Technology by the teaching collegiate. There was a significant statistical difference between the teachers and the wider professional group and this suggests an academic divide for scholarship and rigour in content (Figure 42). Teacher Training: Food teacher index=3.93 (n=60); Areas other than Food Technology index=3.65 (n=26); General secondary index=3.24 (n=33). Non-Teacher Training: Food technologist index=2.99 (n=115); (df=3, F=9.137, sig<.000).
Figure 42: School text and magazines more useful than journals for study purposes

Figure 43 shows that the teachers surveyed feel students choose Food Technology in senior years because they want a career as a food technology teacher. This is often a decision largely driven by teacher interpretation of Food Technology, teacher popularity, and teacher willingness to teach the subject. However, the wider food profession do not share the same view. Teacher Training: General secondary index=3.26 (n=35); Areas other than Food Technology index=3.00 (n=31); Food teacher index=2.93 (n=56). Non-Teacher Training: Food technologist index=2.58 (n=221); (df=3, F=3.469, sig<.017).

Figure 43: Food Technology chosen as a school teaching career choice
Access to computer aided design (CAD) for Food Technology years 7-12 did not show significant responses at alpha set to .05 when assigned to two groups. Teacher Training: index=2.91 (n=124) vs. Non-Teacher Training index=2.58 (n=101); (df=223, t=1.868, p<.063, 2-tailed). However, Figure 44 demonstrates that there was a moderate difference in responses between teachers and the wider profession of food technologists. CAD is a generic name for ‘virtual visualisation’ and can be used to identify molecules in food – it is a way of combining science with cooking as a way to understand basic food engineering principles. Design and communication are closely aligned to physiological problem solving and CAD has the ability to provide science based visuals for molecules and associated food components. Thus, the relationship between CAD and food is that of visual literacy as a way to understand concepts around the molecular structure of food that cannot be seen by the naked eye. An example of this may include looking at the molecular principles connected with obesity. CAD simulations also provide a mechanism to explain how magnesium, for example, is required by many DNA repair mechanisms, or more conversely, provide an understanding in how to design new cooking procedures that may minimise mutagens or carcinogens forming in meat. This may inform new ways for learning and understanding molecular structures of food nutrients in food that is more aligned to laboratory work but through using a digital learning platform. Teacher Training: Areas other than Food Technology index=3.28 (n=40); Food teacher index=2.84 (n=55); General secondary index=2.55 (n=29); (df=3, F=3.038, sig=.030).
Figure 44: Creative graphic design is useful for junior Food Technology classes

There was a significant difference between both groups concerning the importance to undertake experiments for Food Technology students compared to chemistry and biology subjects. Teacher Training (n=156, Teacher index=4.04) vs. Non-Teacher Training (n=159, Food Technologist index=4.28); (df=313, t=-2.527, p<.012, 2-tailed). An unexpected result in Figure 45 shows how the teachers who teach in areas other than Food Technology are more aligned with the food profession. It is clear from the data that the food and general secondary teachers perceive that there is no value for students to undertake science-based experiments. Teacher Training: Areas other than Food Technology index=4.26 (n=43); Food teacher index=4.01 (n=70); General secondary index=3.88 (n=43); (df=3, F=3.631, p<.013).
Food teachers were very aware of the National Food Industry study. Teacher Training (n=131, Teacher index=2.05) vs. Non-Teacher Training (n=125, Food Technologist index=2.30); (df=254, t=-1.710, sig=.088). Although the teachers were more aware than what the wider profession of food technology members were, an interesting conundrum is posed that the teachers have not utilised the content from the CD distributed to all schools in Australia in their teaching given the data thus far (Figure 46). Teacher Training: Food teacher index= 2.47 (n=57); Areas other than Food Technology index= 1.95 (n=39); General secondary index=1.46 (n=35). Non-Teacher Training: Food technologists index= 2.30 (n=256); (df= 3, F= 6.965, p<.000).

Figure 45: Food experiments are important in Food Technology

Figure 46: Awareness of the National Food Industry study 2003
Teacher participants responded that the study of Food Technology provided an excellent foundation to learn food science and technology compared to the wider professional group of food technologists. Teacher Training (n=98, Teacher index=3.73) vs. Non-Teacher Training (n=99, Food Technologist index=3.28); (df=195, t=2.951, p<.004, 2-tailed).

Where the food teachers felt the subject ‘Food Technology’ did not offer a pathway to become a Food Technologist, but more so a pathway to become a food schoolteacher, they perceived the subject as an excellent foundation to learn food science. The data therefore offers some contradiction in Figure 47 by the teachers compared to Figure 41, with a clear indication from the food technologists that the subject had little relevance to learn food science and technology. Teacher Training: Areas other than Food Technology index=3.93 (n=30); General secondary index=3.74 (n=19); Food teacher index=3.61 (n=49). Non-Teacher Training: Food technologist index=3.28 (n=99); (df=3, F=3.450, p<.018).

Figure 47: Food Technology provides for industry food science and technology study

The data in Figure 48 demonstrates the difference between secondary and tertiary study content for Food Technology and also implies that syllabus representation and teacher interpretation have prevented the subject area evolving to its full potential as a science
discipline. Teacher Training: Areas other than Food Technology index=4.00 (n=32); General secondary index=3.62 (n=39); Food teacher index=3.31 (n=51). Non-Teacher Training: Food Technologist index=3.87; (df=3, F=4.938, p<.002).

Figure 48: Controlled research testing is important to study Food Technology

Figure 49 shows that the teachers did not see a need for students to demonstrate strong science and mathematic skills to study Food Technology at secondary school or at a teacher training level, but the wider professional community of Food Technologists perceived it otherwise. Teacher Training (n=116, Teacher index=3.01) vs. Food Technologist Training (n=124, Food Technologist index= 3.85); (df= 1, F=37.778, p<.000. Teacher Training: Areas other then Food Technology index=3.14 (n=29); General secondary index=3.03 (n=32); Food teacher index=2.93 (n=55); (df=3, F=12.779, p<.000).
Figure 49: Mathematics and science skills are essential to study Food Technology

Drawing and mental visualisation tasks enhance food technology studies

Design and communication are closely aligned to physiological problem solving. The data in Figure 50 did not show significant responses at alpha set to .05, but showed a trend towards alpha consistent in theme with significant data. Teacher Training (n=184; mean=3.55); Non-Teacher Training (n=183; mean=3.35); (t=2.028; df=365; p<.043, 2-tailed). The teachers view mental visualisation and abstract thinking as strong considerations to better inform teaching practice and importance to develop cognitive abilities, but the food profession do not see any relevance. However, mental visualisation tasks may further inform the teaching and learning for innovations in food science enhanced through computer applications previously discussed under Figure 44. Teacher Training: General secondary index=3.60 (n=55); Food teacher index=3.54 (n=74); Areas other than food technology index=3.53 (n=55) and Non-teacher Training: Food Science Technologist index=3.35 (n=183). (n=55; mean=3.60); (df=3; F=1.42; sig.=.236).
Computer aided design has relevance for food technology tasks.

This question aimed to expand on the concept of design and communication, and the relevance of digital 2D and 3D design with regard to physiological problem solving. Although the mean was higher for the Non-Teacher Training group (as presented in Figure 51), there was no significant statistical difference between the two groups. Teacher Training group: (n=160; mean=3.16; Non-Teacher Training group: (n=183; mean=3.28. (n=343; t=-1.110; df=341; sig.=.268, 2-tailed). A bi-modal score presents for food teachers and secondary teachers and this may provide an insight into technology genre relevance. However, the results for this question from the Non-Teacher Training group contradict a previous question under Food Technology as an Area of Study, where this group saw no relevance for creative graphic design such as CAD for Food Technology Years 7-12. The higher mean score for the Non-Teacher Training group suggests an interest to explore the CAD environment that may be aligned to laboratory work rather than (for example) creative aspects for packaging design for example. The use of CAD may further inform new ways for learning and understanding around molecular structures.
of food nutrients in food science undergraduate degrees. Teacher Training: Food teacher index=3.15 (n=67); General secondary index=3.15 (n=39); Areas other than food index=3.17 (n=54). Non-Teacher Training: Food technologist index=3.28 (n=183); (df=3; F=.412, sig.=.745).

**Figure 51: Relevance for computer aided design in Food Technology**

*It is easy to integrate information communication technology skills into lessons*

The skill set to integrate ICT into teaching practice presents a significant difference between the two groups, with the capacity being significantly higher in the Teacher Training group compared to the Non-Teacher Training group. Teacher Training index=3.76 (n=186) vs. Non-Teacher Training index=3.32 (n=178); (df=362; t=4.891, p<.000, 2-tailed). Food teachers, and those who teach in areas other than Food Technology, present slightly higher index scores compared to general secondary teachers. However, the teacher group shows a significantly higher index score compared to the wider professional community (Figure 52). This presents a need, particularly for the Non-Teacher Training group to consider extension activities or laboratory in-service training.
where the recording for procedures, workflow and instrument identification is better accessed in a lab environment. Teacher Training: Areas other than food index=3.82 (n=55); Food teacher index=3.75 (n=76); General secondary index=3.73 (n=55) and Non-Teacher Training: Food technologist index=3.32 (n=187); (df=3,F=8.050, p<.000).

**Figure 52: Integration of information communication technology skills**

The FOODWORX CD proved to be a useful teaching resource

As part of the Australian National Food Industry Study in 2003, a CD was sent out to all schools and universities inclusive to an initiative to promote the food industry sectors. The interactive multimedia CD contained information about career opportunities in the agri and food science and technology industries and short video’s of various jobs that ranged from a soft drink technologist to an ice cream flavourist. Learning activities were included for face-to-face delivery of lessons, printable worksheets and revision quizzes. A visual of the CD cover can be located in Appendix 7. This question sought to determine what value the CD posed for teaching and learning in secondary schools and tertiary institutions. There was no statistical significant difference evident in the responses at alpha set to .05 between the two groups. Teacher Training index=3.24 (n=184) vs. Non-Teacher Training
index=3.30 (n=179); (df=361; T=-818, p=.414). However, the food teachers displayed a considerable value in the educational purpose of the CD in Figure 53. Given the consistent analysis theme has leaned toward vocational training by most teachers, the data suggests that not enough emphasis may have been placed on the content as a discipline. Teacher Training: Food teacher index=3.37 (n=76); Areas other than food index=3.19 (n=53); General secondary index=3.13 (n=55) and Non-Teacher Training: Food technologist index=3.30 (n=179); (df=3, F=1.810, sig=.145).

![Figure 53: The Foodworx CD was a valuable teaching resource](image)

Conferences are regular items I track in my diary

The Food Technologists’ emerge as more engaged in research and scholarship in their discipline area compared to the teachers who present as minimal to non-existent. Teacher Training: (n=184, Teacher index=2.53) vs. Non-Teacher Training: (n=182, Food Technologist index=3.16); (df=364, t=-5.810, p<0.000, 2-tailed). Although the general secondary teachers show a higher score compared to the other teachers, Figure 54 suggests that the school culture as a whole does not present as a culture engaged in evolving their subject matter, or evolving as a discipline through research and networking with peers.
Teacher Training: General Secondary index = 2.58 (n=55), Food Teachers index = 2.51 (n=75); Areas other than Food Technology index = 2.50 (n=54). Non-Teacher Training: Food Science Technologist index = 3.16 (n=182); (df=3, F=11.271, p<.000).

![Figure 54: Conference tracking](image)

**Figure 54: Conference tracking**

**Expectations or experiences for professional development**

Seventy-two percent of participants responded no to this question, with twenty-seven percent noting they had sufficient access to professional development (n=382). Figure 55 shows that the Teacher Training group had the highest score for insufficient access to professional development, with the Food Technology teachers displaying the highest score amongst teachers, as shown in Figure 56. This high score suggests a lack of culture for research and in-service training within the educational system. The Non-Teacher Training group also present a high score for a lack of sufficient access to professional development. This could be due to the large proportion of written responses by the undergraduate students for more industry access during their undergraduate degree years. Sufficient access is noted to be adequate for food professionals in paid employment. Those that did
update their knowledge through workshops, although small in response rate, ranged from 3, 6 or every 12 months. (n=276).

![Expectations or Experiences](chart1.png)

**Figure 55: Access to professional development**

![Expectations or Experiences](chart2.png)

**Figure 56: Group breakdown for professional development access**

Thematic analysis of text was undertaken from the qualitative survey section using the Technacy Genre headings: Human Agency (knowledge), Tools and Equipment, and Materials (ingredients, data or ecological resources). The analysis sought to identify philosophy levels for the type of professional development preferred, how it is obtained and participant generic aspirations, if any. Participants from country regions (dominantly
teachers) noted geographic location as an obstacle that also involved accommodation expense if attending in a city area. The Teacher Training group noted the beginning of school term workshops as the most common professional development available. These consist of inter-school workshops within each region. While many teachers noted having never attended a workshop outside of the in-school term workshops, other participants responded that in lieu of physically attending a workshop, knowledge was updated through online sources. Responses from the Non-Teacher Training group consistently noted that the AIFST offered regular and up to date conferences, symposiums and workshops that nurtured networking between students, academics and food professionals. However, there was a clear pattern to suggest that the ability to attend these as in-service training was largely driven by employer support.

Undergraduate food science technology students noted an inability to attend professional development due to budget constraints, as well as a desire for more industry work experience as noted in the following sections for this question. From the category of knowledge, identifiable themes were:

1. School: internship
2. Industry: Internship
3. Workshops or courses
4. Networking through conferences

Figure 57 presents a high proportion of undergraduates from both groups appeared dissatisfied with the lack of school practicum or industry internships offered in their undergraduate degrees. For the undergraduate teachers, and where only school placements were noted as the most preferred compared to showing an interest for industry placements, suggests that pedagogy (teaching method) is more valued than understanding discipline
content. On the other hand, the Non-Teacher undergraduate food science students expressed the need for more science industry placement or internship. Written responses indicated that this would make them more confident in the discipline and therefore ‘lab bench ready’ for the food profession upon graduation—but there appears to be some resistance from food professionals in the industry to collaborate with universities. It was beyond the scope of this study to follow up the detail of why this may be the case. The data also suggests that the Non-Teacher Training group value conferences as a platform for knowledge networking compared to the Teacher Training group who prefer (according to the written responses), in-school workshops (n=101). For tools and equipment, two identifiable themes evident were:

1. Practical VET skills (cooking, computers, metal)
2. Practical science skills (laboratory, industry processing, engineering)

Figure 57 presents a contrast in technology genre for the types of professional development sought for tools and equipment between the Teacher Training and Non-Teacher Training groups. Where the teachers favour cooking and culinary skilling (under the guidance of a chef in an industry setting), and to a minor degree computer applications, the Non-Teacher Training group preference was for learning more science based practical applications. However, the teachers presented a strong interest for science-based content such as laboratory, processing and food engineering, and this suggests a need to provide industry links with food professionals (n=52). For Materials (ingredients, data or ecological resources), two identifiable themes evident were:

1. Nutrition and naturopathy
2. Food industry standards, legislation, product development
Although the responses were small in Figure 57 for the ingredient and material elements, there is a closer alignment between the Teacher Training and Non-Teacher Training group for food industry standards, legislation and product development, consistent with the literature. The Non-Teacher Training group present as being less interested in nutrition and naturopathy compared to the teachers (n=34).

**Figure 57: Professional development in knowledge, tools and ingredients/materials**

*Expectations or experiences for exploring new ways of learning*

The motivation to explore new ways of learning can be attributed to internal or external factors and may determine the amount of effort a person may expend on particular activities in the future. This includes the ability to engage in research and apply abstract thinking, adaptability and entrepreneurial skills to further inform teaching practice. The top three mean scores for both groups listed barriers to their professional development that included a lack of resources, time constraints and inadequate in-service training (Figure
Both groups point to external and employer based barriers to their professional development. This external, rather than personal capability constraint suggests that human agency for innovation tendencies is constrained by tool and material offerings and that the classroom or workplace environment possibly lacks the ability to nurture and develop multi-faceted attributes. Although ranked low, multiple-modes exist for a lack of confidence and classroom facilities for the Non-Teacher Training group. This personal capability could be associated with the undergraduate student responses for the desire to imbed more industry experience into their undergraduate degree for ‘lab bench readiness’ (n=276). Overall, the Teacher Training group present as having more difficulty engaging in new ways of learning compared to the Non-Teacher Training group.

Figure 58: Difficulties exploring new ways of learning
Food technology as a scholarly choice

This question aimed to identify what ranking Food Technology has as a scholarly area of study and what subjects are perceived the most value to teaching and learning for post school job uptake. From a list of fifteen subject areas, ten were ranked in order of preference. Figure 59 displays Food Technology as being ranked last by the teaching collegiate, with Mathematics, Physics, English and Chemistry ranked as the highest four scholarly subjects. In comparison, the wider professional food group ranked Science, Chemistry, Mathematics and Food Technology as the top four scholarly subjects. At best, Food Technology is seen as a soft subject by the teaching collegiate that offers vocational operational skills rather than a scholarly subject directly linked to science, maths and innovation as commonly practiced in the wider food science and technology profession.

This is consistent with the data presented and anecdotal evidence to suggest the subject is still not being taught or promoted as a serious science within schools, and has continued to deliver the subject along the lines of an upgraded Home Economics/Home Science view or food service program, particularly for the junior years (KPA, 2003, p.156). (n=323).
Reasons why food technology should be taught in schools

Thematic analysis of text was undertaken from the qualitative survey section for understanding the reasons why Food Technology should be taught in schools. These were framed using Technacy Genre headings: Human Agent (knowledge), Tools and Equipment, Materials (ingredients, data or ecological resources) to identify knowledge, values and attitude toward job pathways associated with Food Technology and how well sustainability issues are valued. If anything can be read into the following graphs, it is that there is a significant and substantial difference between the Teacher Training and Non-Teacher Training groups. This view was also validated statistically in the Pearson’s correlation index for the perceptions of knowledge, tools and materials used in Food Technology in Figure 33. From the category of knowledge, three identifiable themes were evident:
1 Social life skills
2 Gender and culture
3 Science and research

For knowledge, two domains of practice are evident: social and life skills, and science (Figure 60). Although the Non-Teacher Training group (n=84) listed social and life skills as the second highest, this may suggest that a portion of this group see life skills as a self-sustaining practice, or perhaps it is a reflection on how the subject is currently taught. The teachers (n=110) listed gender and culture as the second most important reason for teaching Food Technology, whereas the food profession noted little relevance. It would be interesting to undertake further study to identify the contrast in values for this response, as it is beyond the scope of this research for now. For Tools and Equipment, two identifiable themes were evident:

1 Cooking and food processing
2 Experiments and food processing

Figure 60 shows the Teacher Training group (n=54) present strongly for cooking and food processing. This heavy emphasis for cooking is evidence of Technacy Genre Theory revealing an uneven distribution of technological practice. In comparison, the Non-Teacher Training group display a small mean score for cooking (n=19). This overlap suggests not all food industry processes occur in a laboratory or processing plant, but often cooking is a process undertaken during preliminary food design and development in a domestic style kitchen. The small response for food experiments by the teachers suggests that some in the teaching collegiate engage in the science of food through experiments to better understand food-processing outcomes. For Materials (ingredients, data or ecological resources), three identifiable themes were evident:
1. Nutrition
2. Food safety and quality
3. Ecology and Food sustainability

An uneven distribution of technological practice by the teachers in Figure 60 suggests a heavily skewed view toward nutrition. Although nutrition is an important element, marginalising other elements constitutes an uneven outcome in technological learning, thinking and practice. Closer parallels were evident for food safety and quality and food sustainability, but given much less importance (n=92). The food profession also valued nutrition the highest (n=56) and for both groups this shows an interest to maintain healthy food choices. However, ecology and food sustainability were noted as the lowest for both groups and this suggests the importance to raise the bar in training to link eco-footprint more deeply into teaching and learning and the expertise and purpose of food research.

![Figure 60: Reasons for teaching Food Technology](image)
Reaction to the NSW 7-10 TAS Syllabus advice for programming

This question aimed to establish how well syllabus conventions have affected change, or re-enforced the status quo for old syllabus content and practice. Although this question was designed for the NSW Teacher Training group specifically, both teachers (n=70) and non-teachers (n=10) responded. There is a clear pattern to suggest the advice for programming was viewed to be on a backward sliding, or at least confused agenda given the negative responses from participants (Figure 61).

![Overall opinion for the New 7-8 and 7-10 years advice for programming](image)

**Figure 61: Agreement for the NSW 7-10 TAS syllabi advice for programming**

Thematic analysis of text was undertaken from the qualitative survey section to identify associations between Human agency (knowledge), and Tools and Materials (ingredients, data, ecological resources) through Technacy Genre headings. All Technacy elements were tallied to identify positive and negative responses. For knowledge, the pattern in Figure 62 suggests that the food teachers saw little knowledge value in the 7-10 syllabus.
Figure 62: Teacher Training: Agreement for knowledge 7-10 TAS syllabi

Comments displayed in Table 5 suggest there has been no cultural change in the syllabi to enable teaching practice for the study of Food Technology innovation. It also suggests that the 7-10 syllabus does not provide an adequate lead-in to the senior Food Technology syllabus. The positive comments largely noted by undergraduate Food Technology student teachers and teachers in Areas other than Food Technology were very scant in description for the type of knowledge valued, and as such provided little scope to analyse any explicit meaning other than, “if it works, then keep doing the same”. Figure 63 and Table 6 show predominately negative responses. This may be due to a dislocation between school equipment type and that used in industry settings.
<table>
<thead>
<tr>
<th>Negative (n=32)</th>
<th>Positive (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-inventing the wheel</td>
<td>Fine</td>
</tr>
<tr>
<td>Low intellectual content</td>
<td>True</td>
</tr>
<tr>
<td>Not moving with the times</td>
<td>Agree</td>
</tr>
<tr>
<td>Isn’t good to rehash old stuff</td>
<td>Logical</td>
</tr>
<tr>
<td>What’s new? Same old thing</td>
<td>Positive</td>
</tr>
<tr>
<td>New is best, get rid of the old</td>
<td>Support this statement</td>
</tr>
<tr>
<td>Time for a shift in programming</td>
<td>If it works, keep doing it</td>
</tr>
<tr>
<td>Lacks defined, measurable tasks</td>
<td>Base to expand on is useful</td>
</tr>
<tr>
<td>Not good enough to lead into higher order thinking skills</td>
<td>Scope and sequencing is doable for timing</td>
</tr>
<tr>
<td>Needs to be interdisciplinary study, not separate areas of study</td>
<td>Manipulating/rearranging existing units OK</td>
</tr>
<tr>
<td>Little scope or desire for innovation</td>
<td>Only the better elements have been reused</td>
</tr>
<tr>
<td>Reassures existing teacher knowledge</td>
<td>Good basis if Food Technology is not a major</td>
</tr>
<tr>
<td>Not up to date with society and the future</td>
<td>All subjects in secondary school have their foundations</td>
</tr>
<tr>
<td>Not enough depth for knowledge capacity</td>
<td></td>
</tr>
<tr>
<td>If this wasn’t so serious, it would be funny</td>
<td></td>
</tr>
<tr>
<td>Historical stuff does not grow new knowledge</td>
<td></td>
</tr>
<tr>
<td>Unrealistic in terms of time to learn knowledge</td>
<td></td>
</tr>
<tr>
<td>Poor understanding of Food Technology by board</td>
<td></td>
</tr>
<tr>
<td>This has promoted the status quo that existed before 2005</td>
<td></td>
</tr>
<tr>
<td>There is no connection between the junior syllabus and the senior syllabus for Food Technology. They are poles apart.</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5: Teacher opinion of 7-10 TAS syllabi*
Materials (ingredients, data or environmental resources) recorded one negative response from a food technology teacher declaring new developments in products were vague (n=1). There were no positive responses. The lack of responses for materials points to a skewed perception for technology practice, and which largely constitutes knowledge as separate to tool and equipment skilling, and that ecology and material use has no consideration. Based

Table 6: Comments for 7-10 TAS syllabi equipment and tools
on technical effort, and where there is too much emphasis on particular lobes and not
enough on another, the focus on the purpose or context becomes lost and the capacity to
synthesize is reduced. Therefore, technology judgement becomes flawed. These
comments and graphs evidence the need for a robust framework, such as Technacy Genre
Theory, to guide curriculum designers and teachers to ensure an even balance in
technological practice is strengthened.

**Understanding the subject matter**

Thematic analysis of text was undertaken from the qualitative survey section for the type
of sources drawn on for teaching. It is possible that the question should have been worded
to ‘understanding subject matter for teaching and the workplace’ and requires re-appraisal.
As a result, the legitimacy concerning response rate in-balance is declared between the
Non-Teacher Training group (n=76) and the Teacher Training group (n=141). The essence
of this question aimed to identify the type of data that is used to inform knowledge and
practice, and what industry associations, training or curriculum support, is utilised to
inform teaching or work practice. The responses were framed using Technacy Genre
headings: Human agency (knowledge), Tools and Equipment and Materials (ingredients,
data, ecological resources). From the category of knowledge as human agency three
identifiable themes were evident:

1. Networking
2. Life and industry skills
3. Self directed research

Figure 64 indicates that teachers’ drew on other teacher’s knowledge, primarily through
shared resources or school development days. Undergraduate students drew on lecturer
knowledge, and teachers during practicum placement, or other students (n=61). Life skills involved trade industry experience that largely constituted the Hospitality industry for the Food Technology teachers or Carpentry and Building from the teachers who teach in Areas other than Food Technology (n=39). A small proportion cited self-directed research (n=15). The Non-Teacher Training group largely interacted with colleagues through networking at conferences, interactions with industry, seminars or workshops or informed knowledge through experiments and laboratory practice (n=38).

For tools and equipment, two identifiable themes were evident:

1. Media
2. Internet

It is clear from the data in Figure 64 that the main tool of choice to source knowledge is through the Internet for both groups (given the ratio of responses previously noted: Teacher Training: n=102; Non-Teacher Training: 28). The data suggests that there has been a move away from traditional modes of sourcing information through hardcopy in libraries, to sourcing information from online books and journals. Discerning between what constitutes an academic website and a non-academic website poses educational issues for both sectors. The Teacher Training group show a preference for media compared to the Non-teacher Training group, however this is consistent with the Teacher Training group use of media such as video, DVD or visual slides as teaching resources in class (for example) compared to the Non-Teacher Training group.

For Materials (ingredients, data, ecological resources), six identifiable themes were evident:

1. Books
2. Syllabus
3. Journals
The data in Figure 64 presents a strong reliance on textbooks by the Teacher Training group (n=68). The Food Technology teachers also accessed magazines and books for recipes, while the teachers who teach in Areas other than Food Technology accessed woodworking books and magazines to inform knowledge. On the other hand, the Non-Teacher Training group’s preferences were for journals, and to a lesser extent, textbooks and books. This qualitative response aligns with the quantitative data in Figure 42 with regard to the academic divide in scholarship and rigour. Teachers, particularly food teachers, favoured textbooks the highest.

Figure 64: Sources for understanding the subject matter
3.2.3 Innovation, Food Technology and Technology Education

**Learner attributes**

This question sought to detect inter-relationships and subtle differences between group trends connected with expressions associated with innovation as they pertain to federal government reports and industry needs and what types of attributes are perceived accordingly \(^{16}\). The research found that teacher’s perceived learner attributes significantly differently to the food profession. Teacher Training index=.55 vs. Non-Teacher Training index=.42 (both n=191, t=5.753, df=380, p<.000, 2-tailed).

Sustained innovation is key to the future growth and prosperity in a global economy. Innovation and a capacity for innovation call for many varied talents such as scientific and mathematical knowledge, and technological capability. Equally important is that students acquire a breadth and depth of knowledge and understanding that is universal. The top ten expressions outlined below draw from federal government policy and food industry reports discussed in sections 1.3.3, 1.3.4 and 2.1.1.3. The innovation index is based on this literature and the following key ten phrasing were chosen for this research:

1. Technical precision
2. Adaptability to change
3. Apply practical common sense

\(^{16}\) Key Results: a high Technacy Genre Index approaching 1.0 suggests strong human agency (tacit knowledge) for innovation and food design orientation; a low index approaching 0.0 suggests strong tool focus (physical equipment) or ingredient/ecology (ethical and cultural appropriateness) focus for innovation and food design orientation. Alpha = 0.05.
4 Safe use of tools and equipment
5 Acceptance of failure for success
6 Ethical and cultural appropriateness
7 Imaginative, enterprising and resourceful
8 Able to follow a detailed blueprint or manual
9 Able to find solutions to problems as they occur
10 Proficiency at using a variety of tools and equipment

Figure 65 shows that the sub-group of secondary teachers display the highest index for innovation attributes compared to the food teachers and those who teach in areas other than Food Technology. Results for the food profession show a strong index toward physical equipment for innovation and food design orientation. Although these attributes are consistent with vocational operational skilling, they are also consistent with laboratory applications and food processes in the food industry. Teacher Training: General secondary index=.61 (n=55); Food teacher index=.53 (n=78); Areas other than Food Technology index=.52 (n=58). Non-Teacher Training: Food Scientist Technologist index=.42 (n=191); (df=3, f=13.086, sig.<.000).

![Figure 65: Innovation index for learner attributes four groups](image)
A closer examination between the teachers and the food profession only were analysed (Figure 66), as their experience may provide a better interpretation for attributes required post schooling. Although the teachers present a strong perception for human agency (tacit knowledge) as essential learner attributes for innovation and food design orientation, the food profession perceive both human agency (tacit knowledge) and tool focus (physical equipment) as essential learner attributes for innovation and food design. Teacher index=.575 (n=53) vs. Food Technologist index=.379 (n=75). (t=5.417, df=126, p<.000, 2 tailed).

**Figure 66: Innovation index for learner attributes two groups**

**Innovation as an area of study**

A Likert Scale containing nineteen questions asked respondents to rate statements according to innovation as an area of study. A Technacy Genre index score of 4-5 for six of the questions suggests a strong science and innovation theme, with the other ten questions suggesting a strong vocational and conservative orientation theme. Three independent questions sought to clarify the difference between creative and innovative, the
value of design within the educational institution, and whether Food Technology syllabi fostered attributes needed in the modern economy. Alpha=.05, n=382.

Summary statements for innovation are outlined below. A comparison table can be located in Appendix 8 that maps these overlapping relationships with the Likert Scale questions.

- The changing nature of technology
- Sustainability of vocational education
- Perceptions of design as a creative enterprise
- Perceptions of innovation as economic enterprise
- Teaching pedagogy and assessment frameworks in education
- Educator willingness to teach design and innovation as a discipline
- Media influence, public opinion and global reality for skills: trades or professions.

There was no significant difference between the Teacher Training and Non-Teacher Training groups. For Innovation: Teacher Training index=2.72 (n=191) vs. Non-Teacher Training index=2.58 (n=191); (df=380, t=1.192, p=.234, 2-tailed). For Vocational skills: Teacher Training index=2.85 (n=191) vs. Non-Teacher Training index=3.01 (n=191); (df=380, t=-1.367, sig=.172, 2-tailed). Data presented in Figures 67 and 68 did not show significant responses at alpha set to 0.5, but does show a trend towards alpha consistent in theme thus far. The data suggests confusion amongst the inside world of the teaching profession between food technology teachers and their collegiate for what the study of innovation should constitute. However, the Non-Teacher Training group displays a skew toward practical based skills (Figure 68). This is consistent with data thus far for the importance of equipment and technical tool skilling required in laboratory work and food processing. For Vocational skills: Teacher Training: General secondary index=3.04 (n=55), Food teacher index=2.81 (n=78), Areas other than Food Technology index=2.74
(n=58); Non-Teacher Training: Food Technologist index=3.01 (n=191). (df=3, F=1.372, p=.251). For Innovation: Teacher Training: General secondary index=2.85 (n=55), Food teacher index=2.70, Areas other than Food Technology index=2.61 (n=58); Non-Teacher Training: 2.58 (n=191); (df=3, f=.946, sig=.418).

Figure 67: Innovation as an area of study

Figure 68: Vocational training as an area of study
Assessment value ranking

This question built upon learner attributes and aimed to identify values assigned to assessment, and in doing so identify problems understanding innovation in order to assess it. Participants were asked to provide a ranking out of 10, in order of importance from a list of 15, for the attributes they would choose as the most value when assessing students in school or the workplace. There was a significant difference between groups. For Vocational Training: Teacher index=6.53 (n=183) vs. Non-Teacher index=6.69 (n=166); (df=347, t=-2.148, p<.032, 2-tailed). Food Innovation: Teacher index=6.87 (n=183) vs. Non=Teacher index=7.18 (n=166); (df=347, t=-1.830, p=.068). Although both groups appear to share similar associations for innovation, the technical aspects weigh more importantly for the food technologists in Table 7. Teacher Training median score=6.86; Non-Teacher Training median score=7.1. Both groups’ median score presented as collaborative skills.

<table>
<thead>
<tr>
<th>Teacher Training group</th>
<th>Non-Teacher Training group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vocational values</strong></td>
<td><strong>Innovation values</strong></td>
</tr>
<tr>
<td>1 Occupational Health &amp; Safety</td>
<td>Technical Skill</td>
</tr>
<tr>
<td>2 Learning new knowledge</td>
<td>Cognitive skill</td>
</tr>
<tr>
<td>3 Innovative idea</td>
<td>Proficiency at using a variety of tools and equipment</td>
</tr>
<tr>
<td>4 Critical reflection</td>
<td>Innovative idea</td>
</tr>
<tr>
<td>5 Task purpose</td>
<td>Collaborative skill</td>
</tr>
<tr>
<td>6 Consideration contexts</td>
<td>Finished product</td>
</tr>
</tbody>
</table>

Table 7: Assessment values for innovation attributes
Although the data for innovation did not show significant responses at alpha set to .05, a trend toward alpha consistent in theme is evident. The food teachers show a high index for innovation assessment values, which contradicts the data presented and may mean that although they may aspire to the importance of these attributes, syllabus requirements and assessment criteria at a senior level are possible constraints (Figure 69). On the other hand, the teachers who teach in Areas other than Food Technology show a high index for vocational training assessment values in Figure 70, which also contradicts the previous question. Additionally, the food technologists were more closely aligned to this group, which again is consistent with their preference for technical expertise in laboratory settings and processing procedures (Figure 70). However, they also show a high index for innovation attributes in accordance with cognitive ability and this suggests that this group perceives both practical skills and knowledge as key drivers for innovation and therefore share equal consideration as assessment values. The general secondary teacher group display confusion for assessment values in Figures 69 & 70. For the food teachers, it is suggested there may be an aspiration gap. Vocational Index - Teacher Training: Areas other than Food Technology index=7.16 (n=55), Food Teachers index=6.28 (n=74), General secondary index=6.22 (n=54). Non-Teacher Training: Food Technologist index=6.97 (n=166); (df=3, F=4.547, p<.004). Innovation index – Teacher Training: Food teacher index=7.05 (n=74), Areas other than Food Technology index=6.85 (n=55), General secondary index=6.66. Non-Teacher Training: Food Technologist index=7.18 (n=166); (df3, F=1.748, sig=.157).
Figure 69: Innovation assessment values

Figure 70: Vocational assessment values
Assessing innovation is easy

Figure 71 shows both groups recorded innovation was easy to assess even though confusion was evident between the groups in the previous question (Teacher Training group, n=67; Non-Teacher Training group, n=52).

![Pie chart showing percentage of participants who found it easy to assess innovation]

**Figure 71: Assessing innovation**

Important ‘generic skills’ for the current and emerging Australian economy

A Likert scale of statements was designed around government agenda language for innovation attributes typically found in government reports and policies. These included:

- Adaptable to change
- Thinking originally and critically
- Capacity for abstract thinking
- Capacity for technical applications
- Creative individuals able to communicate well
• Capable of finding solutions to problems as they occur
• Able to remain motivated when faced with difficult situations.

Common vocational attributes included skill and application in one area of manufacturing, and technical proficiency and experience in an area of expertise.

There was a significant difference between both groups for innovation skills and vocational training skills. For Vocational Training: Teacher Training index=3.46 (n=182) vs. Non-Teacher Training index=3.42 (n=180); (t=.988, df=299, p=.324, 2-tailed). For Innovation: Teacher Training index=4.39 (n=182) vs. Non-Teacher Training index=4.09: (t=5.197, df=354, p<.000, 2-tailed). The food teachers noted highly toward innovation. Teachers who teach in Areas other than Food Technology display a heavy emphasis for vocational skills that is consistent with teacher preference for teaching trade skills and syllabus requirements (Figure 73). However, teachers who teach in core areas such as Maths, Science and English show both practical and cognitive skills as important (Figures 72 and 73). Training: Teacher Training: Areas other than Food Technology index=3.72 (n=43), General secondary index=3.69 (n=35), Food Teachers index=3.25 (n=51). Food scientist technologist index=3.42 (n=(df=3, f=3.011, sig<.030). Innovation: General secondary index=4.51 (n=55), Food Teacher index=4.37 (n=70), Areas other than Food Technology index=4.36 (n=53). Food scientist technologist index=4.09 (n=178); (df=3, f=9.786, sig<.000).
Government “innovation” reports in education and business

Figure 74 presents data comparisons between teachers and undergraduate student teachers only. This question aimed to identify the depth and breadth of sourced literature and also aimed to identify how well practice is a manifestation of theory. The Environmental Education policy shows a fairly even distribution between the two groups and presents as the most widely read document. This poses an interesting conundrum that although the
teachers may have been aware of the study which offered knowledge and insights to the contemporary knowledge and practice in the field of study for sustainability, the data presented as a result suggests that they have ignored the importance of embedding eco-sustainability in their teaching practice. Additionally, the undergraduate students did not display an interest in materials, ingredients and eco-sustainability as Technacy Genre Theory framework identified these key, missing factors through many questions in the survey. Overall, the undergraduate students present as being more informed and aware of government reports around new knowledge and economic directions. It is questionable what the teachers are assessing the undergraduate students in during their practicum experience over a four-year degree: Best practice in knowledge and learning or traditional pedagogic practice such as classroom management strategies? Encouragement for any new pedagogy or new knowledge content in discipline areas a student chooses can only be encouraged but not assessed. This question is beyond the scope of this research and requires further research.
Brain Bender: Knowledge, abstract thinking and vivid imagery are essential for excellence in skill development and should be given more attention in learning and assessment in technology subjects.

Thematic analysis of text was undertaken from the qualitative survey section to determine participant values for learning and assessment (Figure 75). These were framed using Technacy Genre headings: Human Agency (knowledge), Tools and Equipment, Materials (ingredients, data, ecological resources). Initially, responses were tallied to identify positive and negative reactions. For knowledge, a clear pattern was evident that a larger
proportion of participants from both groups felt knowledge, abstract thinking, and vivid imagery are essential in skill development. However, for the Teacher Training group, particularly for the food teachers, this agreement suggests an aspiration–versus–reality context exists given the consistency in theme in the data for vocational training. An unexpected result reveals that the Non-Teacher Training group display a higher disagreement with this statement. It could be argued that mental visualisation tasks may further inform the teaching and learning for innovations in food science enhanced through computer skill applications. (Teacher Training group n=66). (Non-Teacher Training group n=83).

For tools and equipment, two themes were evident:

- Skills develop knowledge
- Skills are more important than knowledge

It is clear from the responses that the term ‘skill’ appears to constitute different interpretations from the Teacher Training and the Non-Teacher Training groups. The majority of teacher responses were from the food teachers and teachers who teach in Areas other than Food Technology. Many felt that skills should be taught without engaging in creativity or design, as this approach offered more scope for slow learners and for those who were creative, naturally blending the two. Another theme emerged that students are ultimately working toward a test or exam that does not constitute the need for abstract thinking and vivid imagery, but rather occupational, health and safety contexts associated with using tools. At a senior level, the teachers did not appear to make a connection with the language in this statement and the similarities of language used in the NSW Higher School Certificate: for example, innovation and creative enterprise. A strong theme around assessment figured prominently but it was noted that these attributes were too hard
to teach and assess. For those teachers who were former trades people, skill was the number one priority and that abstract thinking and vivid imagery could be added on later. However, for the Non-Teacher Training group, tools and equipment shaped knowledge. A strong theme throughout the responses from this group offered that through the use of tools, creative thinking is stimulated and leads to inventions and innovations. Some responses felt that all are important (i.e. practical skills, knowledge and abstract thinking), as one cannot exist without the other—they were seen as interrelated.

For Materials, only two themes were evident by six participants: 1) Meal plating, 2) Food safety and hygiene. Materials, ingredients and ecology demonstrate a very weak association from both groups in relation to technological practice. The lack of responses also suggests there is a need to raise the bar in training and objectives to link eco-footprint more deeply into teaching and learning and the expertise and purpose of research. It is suggested undergraduate degrees and industry direct research talent and resource more toward food innovation as a lighter touch on the earth’

![Core skills for learning and assessment in technology subjects](image)

**Figure 75: Core skills for learning and assessment in technology subjects**
CHAPTER 4: DISCUSSION

4.1 FOOD TECHNOLOGY CURRICULUM AND INNOVATION EXPERTISE FOR THE FIELD

The depths of human ignorance are much more profound than most of us are willing to admit. This is especially so at a time when the global economy is coming together as a more integrated whole than it has ever been, when that economy is pressing against the limits of a wondrously complex planet, and when wholly new ways of thinking are called for. At this time, no one knows enough (Meadows, Randers & Meadows, 2004, p. 280).

The objective for this thesis was to conceptually understand how well Food Technology in NSW secondary schools is placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed technologists, and to what degree the national priority for innovation is being met in curriculum design and teaching pedagogy. To do this, forms of practice and perceptions needed to be identified between both groups involved in this research. A new genre indexing measurement tool was devised to identify teacher training and non-teacher training perceptions, values and technological understandings for Food Technology 17. Prior to this thesis, methods for empirically testing core propositions in Technacy Genre Theory had not been developed. Technacy Genre Theory was designed to detect inter-relationships and subtle differences between technology genres and accordingly bring new currency to the field of technology education. This study developed a method for undertaking a quantitative and qualitative examination of Technacy Genres to help examine the forms of food knowledge pursued by two groups of practitioners: that of “Food Technology” school teachers, and “Food

17 The classes for this study included food technology as a science index and food hospitality as a vocational index. A high Technacy Genre Index approaching 1.0 suggests a strong science, innovation and food design orientation; a low index approaching 0.0 suggests strong vocational, cooking-skills, conservative orientation to the purpose and practice of Food Technology
Technologists”. The information gathered from this approach was captured through the use of perception grids, Likert scales, ranking scales and short answer responses. The findings revealed that there are statistically and substantially different perceptions between the two groups. The outcome presents a serious problem of differing values from both the food technology and science industry and education viewpoints. The following sections discuss the general conclusions drawn from the literature and findings, and the capacity for Technacy Genre Theory to act as an instrument to measure quantitative and qualitative data for identifying forms of technological knowledge and practice. This research aspires to fill a gap in food education research and has contributed to technology education research literature. As a core outcome of this thesis, Technacy Genre Theory offers new schema for technology education that is robust and capable of revealing similarities or differences between two typologies of technology genre.

4.1.1 Synthesis Discussion

This thesis was approached from a holistic perspective by combining the multifaceted aspects of food technology, innovation and teacher education and will be discussed interchangeably in this section. The core drivers influencing the form of food technology practiced by the schools compared to the wider profession of Food technologists were mostly determined on the basis of the purpose to the form itself. It was found that the key purpose drivers included whether the view of the form required it to continually innovate, the practitioners obtain a postgraduate degree, or attitudes towards self-investment in continual professional development was pursued. Food Technology school curriculum is the driver for what teachers teach and what students learn, while assessment tasks appeared to push learning into a certain developmental direction. Conversely, context issues are not drivers as they are defined in Technacy Theory as the conditions in place.
This research aimed to clarify food technology as a school subject and there was sufficient evidence to suggest that the secondary school system is inadvertently encouraging an inaccurate perception of the food science and technology field of study. A mixed method approach was used to ensure a complete and meaningful picture was obtained. The triangulation strategy drew on qualitative and quantitative data collection through interviews, desktop research and a survey instrument. Even though this method was time consuming and costly due the large sample size, the convergence of the findings strengthened the knowledge claims of the study and the applicability of the findings. In addition, the qualitative and quantitative data was cross-referenced with the literature thus overcoming any ideological constraints (Bergman, 2008; Creswell, 2003; De Vaus, 2002; McMillan, 2006).

The results from this research identified a perpetual problem of a flawed knowledge base in curriculum representation and teacher interpretation that has affected rigorous study in food technology. In 2003, a national industry study was undertaken in education and training related to Australian food (KPA). The study found that Food Technology was not taught or promoted as a science but rather as an upgraded home economics program. The findings from this research are consistent with those of the 2003 KPA report and suggest little has changed, further supporting another assertion of this study that the pace of knowledge evolution in the Technological studies areas seems to be tediously slow in the schooling sector. The literature revealed an historical dual position in content for the subject since the 1800’s (i.e. food and chemistry versus food and cooking)\(^\text{18}\). While some shifts have occurred since that period favouring a science approach according to economic

\(^{18}\) Food cooking proponents: Beale, 1870; Beecher, 1865; Beeton, 1861; Bremner, 1897; Donovan, 1830; Martin, 1910; Stowe, 1869; Suttor, 1882 and Walsh, 1856.
Food chemistry proponents: Abel, 1908; Accum, 1821; Bernays, 1853; Campbell, 1913; Marcet, 1805; Phelps, 1834 and Richards, 1889.
change and demand, internal and domestic matters pertaining to cooking and consumption remained extant. There is now a critical need in the 21st century for a cultural shift in Food Technology education in order to meet the national and international demand for food supply and production through human agency in food science and technology.

With the emerging National Curriculum in Australia, this thesis raises the question where a ‘best fit’ sits for the study of Food Technology, given both Science and Food Technology subjects have been highlighted in the literature as subjects not taught well in schools. Rice (2010) in particular raised concerns for the new 7-10 years national science curriculum where generalised ‘big picture ideas’ were at the core of the rationale rather than learning scientific applications through physics, biology and mathematics. The Technologies national curriculum is yet to be finalised, so at the time of writing this thesis it was not clear whether Food Technology will be positioned under Design and Technologies as a national offering or be relegated to the discretion of States and Territories. If the subject is assigned to State and Territory authority, it is argued this poses a ‘business as usual’ position for syllabus content learning that presents a significant problem for advancing the academic study of Food Technology given the historical difficulties raised in the literature within the NSW education system to embrace new pedagogy in the field of technology education and associated teacher capacity.

The findings identified those entering the teaching profession with a trade background in NSW are reinforcing trade skills associated with hospitality. This is consistent with the literature where the current university accreditation body for education, the New South Wales Institute of Teachers, support this VET push. For example, course content requirements for university degree accreditation in secondary Food Technology highlights hospitality as a major area of study under Food Technology. In relation to this, the current trend for articulated pathways between TAFE and university has also produced fast track
degrees for mature age students, further reinforcing a closed loop culture within the schooling system. This trend is interesting when compared to the level of scholarship and relevance in courses. The literature identified the ‘challenging and relevant’ level of study for Food Technology at the lower end of courses for the NSW Board of Studies HSC (2010) while Hospitality was second last as challenging, but slightly higher for relevance. Given the large enrolments in 2010 for Hospitality (11,587 compared to 5,026 for Food Technology), it would be interesting to undertake further research in the job pathway transfer of students from school into the hospitality industries and students entering into the field of food technology and science industries, as this was beyond the scope of this thesis.

The collective affect of these issues prevent the subject area evolving to its full potential so that it may accommodate both technology and science domains, and where particular values that may underpin innovation qualities among learners can be fostered rather than the current formulaic understanding common to general education and VET training in schools. The next section discusses the key findings from the study.

4.1.2 Comparative Contexts: Teacher Training and Non-Teacher Training

While it could be argued that the differences are too great and not in agreement between the school view of Food Technology and the wider professional view of the same, the point of concern is that the subject has not evolved due to the curriculum writers and teacher’s historically acculturated view of the subject. Consequently, this has had a major impact in ‘supplying’ people into professional studies towards a career as a food technologist. The literature highlighted the importance of purpose and context which plays in technical activity as the association with human agency determines the type of
experience learnt and the material and environmental interconnections that may be valued. The research established two contrasting and emergent themes that may contribute to the disparity in teacher training and non-teacher training contexts:

1) Teacher training is humanities oriented, emphasising ‘food technology’ as a general education

2) Non-teacher, technologists training is sciences oriented, emphasising ‘food technology’ and ‘world food demand challenges’ as a scholarship in innovation

These opposing background disciplines between the participants present disagreement due to generalist knowledge rather than specialist knowledge for discipline content. While the food technology industry includes science disciplines, literary offerings from De Vries (1996), Dugger (2010), Ihde (1993), Mumford (1963), and Popper (2002) highlight the different methods and applications between technology and science as being very distinct. However, it is the common ground between the two disciplines of science and technology (Ihde, 1993a; 2009) that could offer ways forward to creatively extend the scope and strengthen the rigour of Food Technology as a subject in schools.

The teacher groupings produced a relative even spread of participants (food teachers, teachers who teach in TAS but may not teach food technology, and general secondary teachers) and collectively generated an even match of participants with the whole group of food technologists and scientists. Gender and age were compared, which revealed a

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19 Where the humanities place less emphasis on the study of a discipline but more about experiencing a general education in the “study of languages and literatures, the arts, history, and philosophy” (Farlex, 2010, para 1), the sciences are largely driven through investigation, systematic knowledge or practice (ibid, 2010), and where explicit scientific content and methods are not sacrificed.

20 As presented in the Methodology section of this thesis, the teacher groups studied included teachers of ‘food technology’, ‘other areas of technology not food’, and ‘all other general secondary teachers’ such as maths, science or history teachers.
dominant female grouping across both groups, but there was higher male gender
dominance evident in the teacher-training group other than teachers of ‘food technology’. The data for teaching or working years presented a 20-year cycle revival into both the teaching profession and the food profession. For the teaching profession, this follows a fifteen-year generational decline in teachers entering or staying in the profession, and a five-year generational gap of industry employees for the food profession. The majority of participants (excluding undergraduate and postgraduate participants) were in full-time employment, which brought practicing currency and an experienced view to the research. The undergraduate year level was predominately third year, so it was a good premise they should know the subject well in their respective field and therefore bring a contemporary view to the research.

The food profession demonstrated a higher capacity for postgraduate study compared to teachers. Where a larger proportion of food professionals (46) listed Graduate Diploma, Masters and Doctoral Thesis completion, teachers (4) on the other hand demonstrated a capacity for TAFE Certificate level qualifications with a small proportion of teachers (7) listing Graduate Diploma, Masters and Doctoral Thesis. This suggests teachers, in comparison to food technologists, do not embrace a culture of research as a way to inform knowledge and practice and this may help explain why the subject has not evolved to meet current market demand for food innovation and research capacity building.

4.1.3 Purpose: Perceptions and Values

Technacy Genre Theory was used to analyse the literature and data for this thesis. The aim was to understand perceptions and values in the context of Food Technology across two different sectors: education and food industry. Consistent with Seemann’s assertion that “Technologies are context sensitive” (2003, p. 36) this section of the discussion examines
the role purpose drivers and context issues have played in shaping the differences in genre
pursued by the groups investigated in this study.

Technacy Genre Theory revealed a significant difference in purpose, perceptions and
values of food knowledge, tools and materials between teachers and the wider profession
of food technologists. Teachers perceived Food Technology as vocational training, while
non-teachers perceived the subject as a science. For science: Non-Teacher Training
index=3.32 (n=157) vs. Teachers index=2.90 (n=158); (df=313, t=-3.250, p<.001, 2-
tailed). For VET: Teacher Training index=3.16 (n=171) vs. Non-Teacher Training
index=2.29 (n=154); (df=323, t=7.064, p<.000, 2-tailed). However, when the four groups
were compared (food teachers; teachers who teach in areas other than food technology;
general secondary teachers; and professional food technologists) an unexpected result
showed that despite the sub-group of teachers who teach in areas other than Food
Technology (and who may not be trained in Food Technology but may teach the subject)
show better agreement with the wider professional community of Food Technologists.
Although there appears some confusion between Figures 34 and 35 regarding vocational
training and science indexes, this may mean that they see the subject currently in a
vocational education domain, but they also perceive an element of science attached to the
subject.

Where food teachers perceived social and life skills, cooking, and food processing as
reasons for Food Technology being taught in schools, the wider professional group held a
different perspective pertaining to science and research, food experiments, and processing
for product development. A common theme for TAS teachers also involved teaching in
the Family Studies and Early Childhood subjects. This correlates with the historical
literature discussed in 2.1.4 that has traditionally held a strong relationship with cooking
and sewing skills and family duties pertaining to the household, and further reinforces the
vocational and soft subject view concerning teacher capabilities in TAS. Nutrition was the only common thread between the two groups, but the food teachers displayed a highly skewed lean toward nutrition compared to the food science and technology professionals and other elements of technological practice. The Education Providers Working Group of the Australian Institute Food Science and Technology (2009) identified that this trend for nutrition studies has impacted on the quality of undergraduate degree content offerings in FST courses, and as a result has marginalised food engineering and other food science skills required for the food industry.

Of particular interest was the high proportion of participants in the teaching collegiate qualified in hospitality prior to entering study for the teaching profession. The reinforcement of the vocational operational skills has presented a significant problem for the Food Science and Technology industry as a discipline area of study in science and innovation. This significant correlation between the qualitative data, fieldwork and literature also explains a likely reason why many Australian food science technology undergraduate degrees have expressed concern for a drop in enrolments in courses (Education Providers Working Group of the Australian Institute Food Science and Technology, 2009). This situation has also been compounded by the dropout rate in the first year of high school leavers who have come from a ‘food technology’ course in their secondary studies, but upon commencement in their university degree have often expressed that the degree in food technology is not what they thought it should constitute based on their experience of the subject studied in school (Dr A. Lee, higher education food technology academic, personal communication, March 24, 2009; Dr J. Cox, higher education food technology academic, personal communication, October 10, 2008). The data validates that students have been presented with a different practice for Food Technology in schools that is dislocated from the wider professional practice of the field.
and that academically the subject offers a poor transfer to food technology undergraduate degrees.

This position was substantiated through a ranking scale out of ten for the academic demands for Food Technology relative to other subjects. The results show the subject was ranked last by the teaching collegiate but fourth highest by the wider professional group (as they perceive the subject ought to be), while Mathematics, Science and English were recorded as the top three scholarly subjects by both groups. At best Food Technology is seen as a soft subject by the teaching collegiate that offers vocational operational skills rather than a scholarly subject driven through science, maths and innovation as commonly practiced in the wider food science and technology profession. This correlates with the literature concerning secondary food curriculum where the subject was identified as one of the least challenging studied in the 2010 NSW Higher School Certificate.

An extension of this view was mirrored in the type of professional development sought by the teaching collegiate. There was a strong desire for hospitality training, particularly from undergraduate students, rather than professional development that enables teachers to develop a detailed understanding of the food science and technology profession. This is consistent with the NSW Institute of Teachers accreditation requirements identified in the literature. Professional development is not just about learning how to apply the curriculum or learning how to work within the confines of large, centralised school system, it is also very much about seeking out new ways of doing things that lead to innovative behaviour as discussed in 2.1.3.3.

The findings also imply school culture knowledge is largely driven ‘in-house’. The teachings collegiate presented as weak in cross-referencing externally for knowledge, but were strong in networking within their fold with other teachers, sourcing mostly in-school
workshops for their professional development and reading school based textbooks. Given teachers write the textbooks for schools, this suggests a highly constructed internal view of the subject matter rather than drawing on external knowledge through scholarly journals or networked links with food professionals. Food and VET trade magazines and cookbooks were prominently evident in the qualitative responses. On the other hand, the wider professional group were strong in networking across and outside their fields of discipline, attending and publishing into research based conferences and industry based workshops, and reading peer reviewed journals or books. The most common relationship between the two groups for sourcing information was the Internet as a tool choice.

There were contrasts evident for cognitive applications and digital tools used in practice aside from the use of the Internet to inform knowledge. This research was interested in the role mental visualisation tasks and digital technologies might play in the study of Food Technology; what role computer aided design (CAD) may play in food industry and the technical expertise to integrate ICT skills into teaching and industry practice. Today’s innovation and knowledge driven economy is undergoing change at an exponential rate demanding that society develop more innovators in this area for our future through education and science and technology research. Information and Communication Technologies play a part in transferring ideas into digitised information and this presents a need, particularly for the Non-Teacher Training group, to consider extension activities or laboratory in-service training where the recording for procedures, workflow, and instrument identification is better accessed in a lab environment.

Mental visualisation and abstract thinking were favoured by teachers to better inform teaching practice and improve cognitive abilities of students, yet the food profession did not see any relevance for their own practice. The capacity for abstraction in problem solving as discussed in 2.1.3 is particularly important as global economic shifts occur
between physical tools and mental tools. This ‘codifiable and transmittable knowledge’ view is consistent with anecdotal evidence as essential drivers for economic input that stimulates creativity and innovation (Fee and Seemann, 2002, p.5; Department Education Science and Training, 2003b; Nonaka & von Krogh, 2009). Design and communication are closely aligned to physiological problem solving and CAD has the ability to provide science based visuals for molecules and associated food components. A bi-modal score presented for the relevance of CAD by food teachers and secondary teachers provides an insight into technology genre relevance. There is reason to suggest that there is a need to also explore the CAD environment, as this may align to laboratory work and further inform new ways for learning and understanding nutrition around molecular structures of food nutrients that is more aligned to laboratory work. This platform has the capacity to introduce new knowledge and may inform new ways of learning for the food technologist and secondary food teachers and may also complete the ‘bench ready’ attributes desired by the food industry.

An important aspect to this study concerned how well the subject offers a job pathway into an undergraduate food technology and science degree. Personal communication with a curriculum officer in Design and Technology at the NSW Department of Education and Training was cited in 2.1.4.3 as declaring that:

Studying Food Technology is not necessarily offered as a job pathway and it is argued quite strongly that it is not a subject that is purely about career choices but in fact it is a general education in health and well being that has great value for anybody whether they choose Food Technology as a career pathway or not (L.Foster, NSW DET Chief Curriculum Officer personal communication, December 7, 2007).

There is an inevitable tension between the educational/liberal view and the vocational/instrumental view. While this comment reinforces the purpose of general education as one that broadens knowledge and offers transferable life skills, the literature suggests schooling ought be a place for developing knowledge and skills in preparing
young people for tertiary education and jobs beyond the school gate. The concept of a liberal education is an ideal template yet it is an idea that presupposes a much fuller account of community and history rather than training students for the labour market.

Nevertheless, teacher perceptions concerning job pathway options perceived a vocational hospitality view of the subject post schooling, which suggests an industry expectation of the subject. Cooking as an important life-skill was highly regarded. The wider profession of food technologists, on the other hand, felt students would study the subject because they are interested in a job as a food technologist. In contradiction to this, personal communication with a teacher involved in the initial scoping exercise for this research revealed another aspect: “students do not take up the subject because they see it as a job pathway to become a food technologist. If students take the subject, it is because of their interest to be a nutritionist or dietician” (L. Percival, personal communication, June 6, 2006). According to the teacher, the senior syllabus was too ‘theory laden’ so students preferred to take hospitality instead because it was easier, not necessarily because they wanted to enter that particular field of work.

On the other hand the findings from the study indicate there is strong evidence to suggest that teachers feel students study the subject because they are interested in entering the teaching profession. A student’s perception at school is often driven through teacher popularity and interpretation of the syllabus and may lead to a career choice as a food technology schoolteacher; this thesis argues that this, more often than not, results in ‘food technology’ schoolteacher graduates returning and reinforcing the original school perceptions that are often based on 19th century practice. Nevertheless, the TAS teachers showed confusion regarding where the subject is currently sitting and where it needs to go. Yet the teachers who teach in core areas such as Maths, Science and English were more
aligned with the wider professional group who saw or expected the subject to be more orientated towards the science domain.

While the literature articulated the historical conventional approach in technology and food technology education has been to develop student mastery of methods and techniques, it is argued that for innovation capacity building today a deeper level of learning is required to “prepare people with the skills and knowledge needed to identify and shape the quality of the world we share with others” (Gruenewald, 2004, p. 2). These desirable skills noted in the literature and relevant to innovation also involve:

…the ability to identify and exploit cross-knowledge or cross-domain patterns (also known as transfer and abstraction skills); apply ideas into unfamiliar settings; break boundaries; problem solve and conceptualise as a part of a team (Australian Government Department Education Science Training, (DEST), 2003 Fee & Seemann, 2002; Kenway, Bullen, Fahey, & Robb, 2006).

As a subject in the twenty first century, Food Technology needs to have a clear position for the ecological landscape and demonstrate the capacity to nurture the socialisation of people who are inclined to be innovative toward the design of food as a sustainable technological and scientific enterprise. The need to develop suitable attributes and ways of practice in food education is evidenced in the literature and is not isolated to Australia. Jideani & Jideani (2010, p. 4826) cite the need to move away from the “Home economics/catering image” and for a new model to promote food science and technology in African high schools. Rutland, Barlex & Jepson (2005, p. 153) also highlight in Britain “design skills lag behind making skills” and refer to the problematic position when there is an attempt to move away from the traditional, domestic focus of food courses.

In order to develop attributes that foster student’s social, cultural, and environmental sustainability awareness, curriculum requires a standard classification scheme to describe innovation attributes in universal terms, and in stages of development. This study showed
that teacher’s perceived learner attributes significantly differently to the food profession. Teacher Training index = .55 vs. Non-Teacher Training index = .42 (both n=191, t=5.753, df=380, p<.000, 2-tailed). The food profession showed a strong index toward physical equipment as innovation and food design orientation, consistent with laboratory operations and food processing. Yet when only the practicing teachers and practicing food technologists were compared, the teacher-training group identified tacit knowledge (inclusive of human agency) as an essential attribute; whereas the food profession identified both physical equipment and tacit knowledge as essential learner attributes for innovation and food design. This suggests tools and equipment fundamentally drive innovation and knowledge development, consistent with Dewey’s earlier work concerning the relationship between people and their technical activities.

Innovation as an area of study showed no significant difference between teachers and the food professionals. This suggests a possible question design error or that innovation, as an area of study, is too complex to identify to any significant degree of separation. This was brought to light from the writings of Schumpeter, Drucker, Tarde, Trist and Rogers in section 2.1.3.3. On the other hand, teachers poorly understood innovation; commonly referred to as ‘being creative’ rather than as a socio-technical process that is multidisciplinary in nature (Rogers, 2003). It is argued that innovation is poorly presented in the junior NSW Food Technology syllabus. Students are able to learn to design an innovative product under a minor dot-point or as additional content, but there is no foundational learning about innovation as a research and development process in the ‘Learn About’ content. Food Innovation was removed altogether in 1999 from the senior NSW Food Technology syllabus.

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21 Key Results: a high Technacy Genre Index approaching 1.0 suggests strong human agency (tacit knowledge) for innovation and food design orientation; a low index approaching 0.0 suggests strong tool focus (physical equipment) or ingredient/ecology (ethical and cultural appropriateness) focus for innovation and food design orientation. Alpha = 0.05.
In comparison, assessing innovation produced a significant difference between groups. A ranking for important attributes in assessment demonstrated that purpose and context are important considerations in technological practice as the technical aspects weighed more heavily for the food technologists. The relevance for manufacturing skills and the ability to practice, teach, and assess human adaptability skills have long been a point of debate between industry and educational institutions (Toner, 2011). Important generic skills for the current and emerging Australian economy produced significantly different results. The data suggests an aspiration gap for the food teachers in their capacity to deliver highly toward innovation skills, while the teachers in areas other than food technology display a heavy emphasis toward vocational skilling commensurate to trade skills. General secondary teachers and the wider professional group perceived important generic skills as both cognitive and practical in nature. Given that a high percentage of general secondary teachers hold science degrees it is reasonable to suggest that this group has aligned across a number of questions with the food profession. Additionally, the Non-Teacher Training group, although they cited generic skills as vocational, displays a re-occurring pattern consistent with the data for the importance placed on skill application and technical precision in food product development. As a result, Technacy Genre Theory was able to reveal the importance of purpose and context for technological applications.

Historically, society experienced a stable, slow pace of change and simply designed technologies with limiting impact on society. Today’s society, however, experiences rapid change with technologies superseding themselves within months. This shift places school leavers seeking jobs in a constantly changing environment, therefore their employability skills will need to be multifaceted to demonstrate a capacity for sustainable, long-term decision-making, the ability to utilise tools and equipment, and ingredients and materials choices that leave a low carbon footprint on the environment (Slaughter, 1999). Although
the undergraduate students present as more informed and aware of government reports around new knowledge and economic directions in sustainability, eco-sustainability compared extremely low between all groups compared to other elements of technological practice. The Environmental Education policy presents as the most widely read document, yet the importance of embedding eco-sustainability in practice and the importance of material aspects did not emerge from the data. Both groups appear to be in need of increasing their respective understanding of the ecological aspect to their forms of practice. Technacy Genre Theory offers a framework to do this for not only Food Technology and other forms of technology genre in schooling and teacher education, but also for the FST profession, in that it allows for sustainable and effective understandings and learning of technological practice holistically.

Technacy Genre Theory was able to identify when an element of technological practice is marginalised in favour of another. The result is an uneven distribution in technological knowledge as a basis for rounded judgement in each group’s respective genre of practice. The usefulness of this system for this research is critiqued in the next section.

4.1.4 Technacy Genre Theory: A Scaffold for Technological Understanding

Technacy Genre Theory can be couched as a deceptively simple yet elegant framework due to its fractal nature. This is an interesting aspect to the theory as it is scalable. Anything that is produced in the lobe elements is connected to the middle (purpose and context), and anything that is a product of the middle is transferable to the lobes. When there is an uneven load between the elements, a skewed outcome occurs. Alternatively, this framework could be mapped to other technological perspectives in other domains not related to human activity. Technacy Genre Theory also has the context of time and, as
such, provides a way to identify context specific technologies. Framing the purpose and context is critical to ensure key learning occurs for technology genre rather than a general or peripheral understanding.

The value and importance of this study is underpinned through the design of Technacy Genre Theory as an indexing instrument. For the purpose of this study the system was used to determine different domains of technology practice. This new research was adapted from Seemann’s work in Technacy Theory and positions this thesis in connection to the wider debates about food, innovation and teacher education. A key outcome from this research was achieved through a three-way correlation across the three elements of Technacy Genre Theory, simulated through perception grids where two domains of practice under the label of Food Technology were made transparent (Figure 33). Priority systems of Food Technology knowledge/techniques, tools/equipment and ingredients/materials were perceived significantly different by the teaching collegiate compared to the wider food profession. In this aspect the framework has been useful in identifying purpose and contextual factors for technological activity, and achieved its purpose in identifying why the problem exists between the school view of food technology and the wider professional view of the same.

According to the technacy elements, disciplined thinking for this research looked for patterns in the evolution of technology and philosophical understandings, economy, curriculum, policy and education in technology and food technology. This provided a framing for comparing changes over time, as a good theory tends to accommodate history and improve on it. A good theory also suggests areas or pathways that need to be included, and they suggest relationships between the paths (Sutton, 2001). It was for this reason that Technacy Genre Theory was chosen for this research, as it was able to draw together and frame perceptions around technology practice over time without discounting the history.
Yet Technacy Genre Theory does have limitations in that it does not proclaim to say one element of practice is better over another; nor is it able to explain phenomena surrounding innovation. Instead, the framework has the capacity to identify favoured elements of practice and act as a predictive equalizer to ensure well-rounded judgments and decisions are made during technological practice. At the same time, technacy does not identify innovation in any specific way but rather the theory suggests innovation is a fundamental pattern of technological activity. In reflection Technacy Genre Theory was essentially solid as it helped to understand technological factors over time across different economic contexts.

Technacy Genre Theory was applied to the method as a way to operationalise the broad concepts for this study and was used as a critical review of the literature. The findings from this research clearly indicate the capacity for the framework to analyse quantitative data however reviewing the qualitative data using this method proved to be time consuming and awkward. Although patterns were revealed that indicated a link with the quantitative findings, this method may work better if the questions were more tightly structured. Conversely, Technacy Genre Theory revealed ecology did not feature prominently in many responses, but at the time of designing the survey instrument using ‘prompt specific questions’ would have yielded biased responses in the researcher’s view. Nevertheless better design efficiencies of the survey instrument questions could be improved for further use in specifically identifying knowledge, values and perceptions in this topical area.

The lack of precedence for this study and the need to accommodate relevant questions for two different sectors resulted in a very large battery of questions, which discouraged some initial participant interest. The response rates were increased through follow-up phone calls to schools in particular, and additional fieldwork to universities, which brought
networking opportunities to the research but also added considerable time to the study initially not built into the schedule. The attempt to replicate the hard copy version of the survey instrument into an online version was problematic. For example, short sections rather than long continuous sections would have improved the pace online and data output efficiencies.

In summary it was demonstrated that comparative measures using the Technacy Genre perception index identified the existence of technology types, and clarified a long-standing problem in the context of Food Technology in schools, relative to the wider professional expectation of the same. This thesis proposes that Technacy Genre Theory has the ability to synergise various elements into a simple formula to explain reality. This theory was able to classify information as well as establish a theoretical position for those relationships and as such was the best option for the context of this thesis.
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 OVERVIEW

Like the global climate to which we are all subject, the global food supply will decree our fate, no matter who we are or where we live. If through our neglect or abuse of resources fails, each of us will bear the consequences (Cribb, 2010, p. 202).

This is the first study of its kind to scrutinize and test the proposition that forms or genres of technological knowledge and practice exist and can be empirically identified. The research focused on food technology for its context of study because this field presented an expressed concern where the school view of the subject was not aligned with the wider professional view of it, even though both views assert the label they use as the authority for its form. The main research question asked: To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists?

The methods devised for this study are original and significant because the plight of Food Technology as a subject in schooling has been revealed as having a low status and thus lives in the shadow of academic subjects. The study found that the reason why food technology in school systems and food technology in the wider industry were not in agreement with what each asserted to be the study of ‘Food Technology’ was that they were engaged in substantially different forms or genres of technological knowledge and practice. Further that the basis of their difference conformed to the propositions of Technacy Genre Theory. The study also found that the school sector struggled to keep
pace at a curriculum and teacher training level with advances in the wider professional field.

The study drew specific attention to human agency, tools and equipment, materials and ingredients associated with Food Technology. It was found that there exists an acculturated view of the subject and as such it has become substantially and significantly dislocated from the accelerated field of knowledge of the wider professional practice of food technologists. The result of this is that the subject has not generated a curriculum high in status and the stigmatising of Food Technology has presented a significant problem for the food technology and science industries.

5.2 CONCLUSIONS

Chapter 1 raised the concern that schools, for many reasons, have been struggling to keep up with the outside world, particularly in technology education, and specifically in Food Technology. The wider professional food technology industry has accelerated enormously in its own science outside of the school gate, but the inside school view for food education remains ‘food consumption’ driven. While the challenge to feed the world and to develop innovative and sustainable new food products and production methods exist, it is debatable whether schooling is right or wrong in continuing a tradition steeped in vocational operational skilling for this subject. If we accept the essential contexts in which Food Technology education must succeed, it is proposed that the successful terms and conditions are for a more sustainable education in Food Technology that addresses the need for students to enter a pathway into the food technology and science industries. This situation invites us to question the assumptions of the dominant discourse in education, content and teaching methods and favour more the concepts and skills needed for finding technological and scientific solutions to food problems. The approach needed requires building an
understanding in the relationship between technology education pedagogy for change and ecological sustainability, and human development.

This chapter also identified the need for a robust framework that could clearly articulate technological understandings. This study aimed to quantify those perceptions as a way to comprehend the existing perceptions between teachers and professional food technologists. Chapter 1 concluded with a definition of terms for technology, technacy, innovation and food technology as meanings of words, which are often used incorrectly and the difficulties that arise from this are apparent, for example, in the labelling of ‘Food Technology’. Another misinterpretation by the teaching collegiate largely ignores the economic importance attached to innovation. Three questions were posed in Chapter 2, which sit at the heart of this thesis:

To what extent is Food Technology in schooling well placed to meet emerging policy and economic demand for food innovation expertise as innovative and sustainability informed Food Technologists?

a) What is the evolution of policy and industry knowledge in Food Technology?

b) How can forms of technology practice be identified in Food Technology education?

To address these questions, the thesis developed in Chapter 2 a theoretical framework and methodology to conduct the research. The theoretical framework examined the epistemological basis to a study of technology highlighting the importance of praxis expressed through Technacy Genre Theory. This allowed common themes of philosophy and technological practice to be identified and compared to contemporary thinking and practice in food technology education. Consistent with Technacy Genre Theory was the need to examine the temporal context of the changing political and economic landscape.
that included: 1) demand drivers such as federal, state and government-industry linked initiatives, and 2) supply drivers, such as state, school, teacher education, classroom culture and curriculum. Reoccurring broad themes were identified that provided a dimension to understand the purpose of innovation across comparative contexts and more about human qualities and technical aspects in relation to innovation. Secondary Food Technology curriculum and food technology industry curriculum at a higher education level were compared in order to gauge the continuum of study from secondary schooling and undergraduate study in food technology and science. A shortfall of knowledge continuum was evident from the secondary schooling supply end.

Sub-question a) of this research was answered through exploring priority innovation and priority food policies. The purpose of education and food policies presented as a contrasting agenda between NSW schools, the Australian government and the wider food profession. Food syllabi policy has not been adaptive to contemporary economic change and that the national priority for innovation is falling short due to the same conservative values.

The literature revealed an historical pattern of ongoing debate between vocational skilling and scientific and technological applications. In response to the main question, a domestic view of Food Technology is evident and this has not changed in theme since the early 1800’s. This thesis states a case for urgent change in food technology curriculum so that the subject is positioned as a rigorous study in food science and innovation as practiced in the wider field of professional food technologists. As a supply driver, Food Technology in secondary schooling unfolded as a subject that is not well placed to meet emerging policy and economic demand; neither for food innovation expertise, nor as a subject capable of nurturing innovative and sustainability informed Food Technologists for the future.
Part 2 of Chapter 2 explained the research methodology, which was structured around contextual (teacher and non-teachers) and goal orientated (purpose) aspects of practice (technological understandings). The methodology used a triangulation approach that involved interviews and classroom observations, desktop research and the use of a survey instrument for qualitative and quantitative data analysis. The key concepts of Technacy Theory were an underlying theme and an influencing account of current perceptions in society today around technology education and food technology specifically. These perceptions have a long history, and the importance to research this from an historical perspective enabled an understanding for why these traditions are hard to break.

Sub-question b) of this research was answered through both the theoretical framework articulated in Chapter 2 and the findings in Chapter 3 using Technacy Genre Theory as the framework for detecting forms of food technology knowledge and practice. Technacy Genre Theory empirically detected different genre of technology practice. This proved to be a highly effective tool to detect different types of closely related or different technologies in perception and practice. From a theoretical significance, the instrument was able to demonstrate that it is possible to create an indexing system that can distinguish between two different types of technology genre under the same label — Food Technology was used as an example for this thesis. The instrument produced very powerful levels of significance in genre co-relationships existing between food knowledge, techniques, ingredients and tools. This study demonstrated that Technacy Genre Theory, qualitative in nature as a theory prior to this research, could be translated into a quantitative measurable model.

The main aspect evident from this research is that there is a major disconnect between the NSW school perception of Food Technology and the wider food technology industry under the same label. Teachers appear to be maximising internal, localised referencing rather
than wider contextual (out of education sector) scoping, which has produced an internal closed feedback cycle of refinement drivers to the curriculum rather than drivers of evolution and innovation in the curriculum. This situation has had a significant undesirable impact on both school leavers entering into the Food Science and Technology industry, and the supply of next generation food scientists. If a theoretical reformulation of Food Technology education were possible, this would make NSW a leader, both nationally and internationally, by introducing a mindset for the century after this; rather than from the century before the last one, else further damage to our planet may occur if the conservative ways of old remain.
5.3 RECOMMENDATIONS AND FURTHER RESEARCH

5.3.1. Recommendations

Attention is drawn to the need for food curriculum to align more toward a common interest for sustainable food production as a life sustaining enterprise—for schools to re-label the subject area so as not to confuse it in a stalemate of rhetoric compared to the wider professional demand for it to rapidly evolve. The opportunity for schools to be champions in food sustainability, engage in new food science research knowledge and design, and to link eco-footprint more deeply into teaching and learning is needed to take the industrialised world to its next stage of evolution. A way forward for this message to be heard is for school curriculum designers, in collaboration with food science technology professionals and university academics, to design a new ‘Food Science’ or ‘Food Science and Innovation Studies’ syllabus that is positioned under the sciences strands for national curriculum consideration and run as a curriculum alternative. This would aim to maximise laboratory devices, contexts and cultures of practice.

An alternative suggestion would be to place the subject under the proposed National Curriculum core strand, ‘Technologies’, as a new ‘Food Innovation’ or ‘Food Innovation Studies’ subject. This would reflect a world-class futures orientated curriculum that would raise the knowledge and market agency of Australian expertise in food sustainability and satisfy a crucial pathway to post-school success in food science and technology careers. It may be appropriate to consider professional development for teachers to involve mandatory food science and technology workshops targeting the laboratories of the food science industries and AIFST conference attendance as a way to broaden teacher networks and inform knowledge and practice in food technology and science.
In order to maintain the existing link with food hospitality offerings in schools, a shift is recommended to change the labelling of the current model of Food Technology to a more generic form, such as ‘Food Studies’ or “Food Studies and Hospitality’. This would allow for more depth of learning in nutrition given food teachers’ strong interest in this area, and be positioned under the VOCED strand of subjects if the current practice in schools is seen to be sufficiently important as it currently is. If the stand off between the school view of Food Technology and the wider demand for it to evolve remains in this catatonic state, the subject area in some school systems may well erode its claim to relevance. It was this conundrum that formed the impetus for this study.

5.3.2. Further Research

Of significance to this thesis was the poor transfer of students from Food Technology in schooling into undergraduate degrees for the Food Technology industry. There is enough evidence to indicate further research in this area would be of benefit to improve job pathways into the food technology and science industries.

Age and gender comparisons from the existing data could be further expanded upon in future academic articles. Although assessment is a driver in education, how we should assess and what we should assess was not really core to this research. But there is sufficient evidence to suggest that Technacy Genre Theory could be useful in advancing assessment practice in innovation and ecology and provide potential scope for planning efficiencies in education programming to avoid overlap in content.

This study aimed to develop a more comprehensive understanding of the subject Food Technology to accommodate both the future of schooling in this area as well as the development of the profession outside of school. Further research in other technology
genre (for example, woodworking in schools and how this measures against job pathways to building or cabinetmaking industries) would improve the utility of the methodology and theoretical framework beyond the current research. In particular, further research into the method used to identify technacy genres offers a new pioneering field of inquiry and has the potential to transform the curriculum in technological studies if appropriately evolved. The basis of this potential lies in the ability for an indexing numeric to be applied as a basis for analysing any two genres of technology. The ability to map the entire field of technological knowledge into a networked association of genres poses new and exciting epistemological as well as pedagogical possibilities.
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Appendix 1

Ethics approval and survey instrument
23rd August 2006

Dr Kurt Seemann and Ms Angela Turner
School of Education
SCU Coffs Harbour Campus
Hogbin Drive
Coffs Harbour NSW 2450

HUMAN RESEARCH ETHICS COMMITTEE

Approval of project: A Critique of Food Technology, Innovation and Teacher Education: a Technacy Perspective.

2006 Ethics Approval Number ECN-06-70

On the 23 May 2006, the HREC reviewed the above application for ethics approval. The HREC approved this research subject to some special conditions. All special conditions, including those mentioned in an email to the HREC Secretary dated the 16/5/06 were included in the letter to the researchers dated 23/5/06.

The researchers have provided their responses to the special conditions and they are all satisfactory. Therefore, this project that involves the Stage 1 scoping and pilot exercise, has final approval from HREC subject to the mandatory standard conditions of approval below.

The following standard conditions are mandatory to all ethics approvals.

Standard Conditions (in accordance with the Guidelines of the NHMRC National Statement on Ethical Conduct in Research Involving Humans) referred to as The National Statement (NS).

1. Monitoring
   NS 2.33
   An institution or organisation and its HREC have the responsibility to ensure that the conduct of all research approved by the HREC is monitored by procedures and/or by utilising existing mechanisms within the institution or organisation which will ensure the achievement of the goals for monitoring as determined by the institution or organisation and the HREC.
NS 2.36

An HREC may recommend and/or adopt any additional appropriate mechanism for monitoring including random inspections of research sites, data and signed consent forms, and/or interview, with their prior consent, of research participants.

(a) That the principal investigator/person responsible (usually the Supervisor) and the researcher/s provide a report after 12 months on the progress to date or outcome in the case of completed research, specifically including:
   • Evidence that the maintenance and security of research records is being maintained.
   • Compliance with the approved consent protocols and documentation.
   • Compliance with any conditions of approval.
   • Any changes of protocol to the research.

Note: Compliance to the reporting is mandatory to the approval of this research.

(b) Specifically, that the principal investigator/person responsible and/or associates report immediately and notify the HREC, in writing, for approval of any change in protocol. (NS 2.37)

(c) That a full report is sent to HREC when the project has been completed.

(d) That the principal investigator/person responsible and/or associates report immediately anything that might affect ethical acceptance of the research protocol. (NS 2.37)

(e) That the principal investigator/person responsible and/or associates report immediately any serious adverse events/effects on participants. (NS 2.37)

(f) That the principal investigator/person responsible and/or associates report immediately any unforeseen events that might affect continued ethical acceptability of the project. (NS 2.37)

2. Complaints

NS 2.39

An institution or organisation with an HREC shall establish mechanisms for receiving and promptly handling complaints or concerns about the conduct of an approved research project.

All Participants MUST be advised in writing that:

The ethical aspects of this study have been approved by the Southern Cross University Human Research Ethics Committee. The Approval Number is ECN-06-70. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Ethics Complaints Officer: Ms Sue Kell
Ethics Complaints Officer and Secretary
HREC
Southern Cross University
PO Box 157
Lismore, NSW, 2480
Telephone (02) 6626-9139 or fax (02) 6626-9145
Email: sue.kelly@scu.edu.au

All complaints, in the first instance, should be in writing to the above address. All complaints are investigated fully and according to due process under the National Statement on Ethical Conduct in Research Involving Humans and this University. Any complaint you make will be treated in confidence and you will be informed of the outcome.

Sue Kelly
Secretary & Ethics Complaints Officer
HREC
Ph: (02) 6626 9139
sue.kelly@scu.edu.au

Associate Professor Baden Offord
Chair, HREC
Ph: (02) 6620 3162
baden.offord@scu.edu.au
Mrs Angela Turner  
PO Box 453  
Macksville NSW 2447

Dear Mrs Turner  

SERAP Number: 06.336

I refer to your application to conduct a research project in NSW government schools entitled A Critique of Food Technology, Innovation and Teacher Education: a Technacy Perspective. I am pleased to inform you that your application has been approved. You may now contact the Principals of the nominated schools to seek their participation.

This approval will remain valid until 23 August 2007.

This approval does not cover researchers and research assistants entering schools for the purposes of this research.

You should include a copy of this letter with the documents you send to schools.

I draw your attention to the following requirements for all researchers in NSW government schools:

- School Principals have the right to withdraw the school from the study at any time. The approval of the Principal for the specific method of gathering information for the school must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school’s convenience.
- Any proposal to publish the outcomes of the study should be discussed with the Research Approvals Officer before publication proceeds.

When your study is completed please forward your report marked to General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Dr Christine Ewan  
General Manager, Planning and Innovation  

19 December 06
HUMAN RESEARCH ETHICS COMMITTEE (HREC)
NOTIFICATION

To: Dr Kurt Seemann/Angela Turner
    School of Tourism and Hospitality Management
    angela.turner@scu.edu.au,kurt.seemann@scu.edu.au

From: Secretary, Human Research Ethics Committee
    Graduate Research College, R. Block

Date: 22 July 2008

Project: Food Technology, Innovation and Teacher Education: A Technacy
        Perspective of Curriculum

Approval Number: ECN-08-081

The Southern Cross University Human Research Ethics Committee has
established, in accordance with the National Statement on Ethical Conduct in
Human Research – Section 5/Processes of Research Governance and Ethical Review, a procedure for expedited
review by a delegated authority.

This application was considered by the Human Research Ethics Sub-Committee at
Coffs Harbour, and it has now been approved subject to the standard conditions of
approval.

Research may commence. However, this approval will be ratified by the full HREC at
the 15 September HREC meeting. If the full HREC does have any further queries, then
the researchers are expected to answer the queries satisfactorily.

Standard Conditions in accordance with the National Statement on Ethical Conduct in
Human Research (National Statement) (NS).

1. Monitoring
   NS 5.5.1 – 5.5.10
   Responsibility for ensuring that research is reliably monitored lies with the institution
under which the research is conducted. Mechanisms for monitoring can include:
   (a) reports from researchers;
   (b) reports from independent agencies (such as a data and safety monitoring
       board); (c) review of adverse event reports;
   (d) random inspections of research sites, data, or consent documentation; and
   (e) interviews with research participants or other forms of feedback from
       them. The following should be noted:
(a) All ethics approvals are valid for **12 months** unless specified otherwise. If research is continuing after 12 months, then the ethics approval MUST be renewed. Complete the Annual Report/Renewal form and send to the Secretary of the HREC.

(b) **NS 5.5.5**
Generally, the researcher/s **provide a report every 12 months** on the progress to date or outcome in the case of completed research specifically including:
- The maintenance and security of the records.
- Compliance with the approved proposal
- Compliance with any conditions of approval.
- Any changes of protocol to the research.

Note: Compliance to the reporting is **mandatory** to the approval of this research.

(c) Specifically, that the researchers **report immediately and notify the HREC, in writing, for approval of any change in protocol. NS 5.5.3**

(d) That a report is sent to HREC when the **project has been completed.**

(e) That the researchers **report immediately any circumstance that might affect ethical acceptance of the research protocol. NS 5.5.3**

(f) That the researchers **report immediately any serious adverse events/effects on participants. NS 5.5.3**

2. **Research conducted overseas**

   **NS 4.8.1 – 4.8.21**
That, if research is conducted in a country other than Australia, **all research protocols for that country are followed ethically and with appropriate cultural sensitivity.**

3. **Complaints**

   **NS 5.6.1 – 5.6.7**
Institutions may receive complaints about researchers or the conduct of research, or about the conduct of a Human Research Ethics Committee (HREC) or other review body. Complaints may be made by participants, researchers, staff of institutions, or others. All complaints should be handled promptly and sensitively.

*Complaints about the ethical conduct of this research should be addressed in writing to the following:*

Ethics Complaints Officer
HREC
Southern Cross University
PO Box 157
Lismore, NSW, 2480
Email: sue.kelly@scu.edu.au
All complaints are investigated fully and according to due process under the National Statement on Ethical Conduct in Human Research and this University. Any complaint you make will be treated in confidence and you will be informed of the outcome.

All participants in research conducted by Southern Cross University should be advised of the above procedure and be given a copy of the contact details for the Complaints Officer. They should also be aware of the ethics approval number issued by the Human Research Ethics Committee.

Sue Kelly
Secretary HREC
Ph: +61 6626 9139
sue.kelly@scu.edu.au

Professor Bill Boyd
Chair, HREC
Ph: (02) 6620 3650
William.boyd@scu.edu.au
PLANNING AND INNOVATION

Mrs Angela Turner
P O Box 453
MACKSVILLE NSW 2447
AUSTRALIA

Dear Mrs Turner

I refer to your application to conduct a research project in NSW government schools entitled A Critique of Food Technology, Innovation and Teacher Education: A Technacy Perspective on Curriculum. I am pleased to inform you that your application has been approved. You may now contact the Principals of the nominated schools to seek their participation.

This approval will remain valid until 22 July 2009.

No researchers or research assistants have been screened to interact with or observe children for the purposes of this research.

You should include a copy of this letter with the documents you send to schools.

I draw your attention to the following requirements for all researchers in NSW government schools:

- School Principals have the right to withdraw the school from the study at any time. The approval of the Principal for the specific method of gathering information for the school must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school’s convenience.
- Any proposal to publish the outcomes of the study should be discussed with the Research Approvals Officer before publication proceeds.

When your study is completed please forward your report marked to General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Dr Jenny Donovan
General Manager, Planning and Innovation
12 September 08
HUMAN RESEARCH ETHICS COMMITTEE (HREC) NOTIFICATION

To: Dr Kurt Seemann/Angela Turner School of Education
   kurt.seemann@scu.edu.au, angela.turner@scu.edu.au

From: Secretary, Human Research Ethics Committee
      Division of Research, R. Block

Date: 18 August 2009

Project: A Critique of Food Technology, Innovation and Teacher Education: A Technacy Perspective of Curriculum.
Change of Protocol – use of an online survey.

Approval Number ECN-08-081

The Southern Cross University Human Research Ethics Committee has established, in accordance with the National Statement on Ethical Conduct in Human Research – Section 5/Processes of Research Governance and Ethical Review, a procedure for expedited review by a delegated authority.

This has been approved and your research may commence.

The approval is subject to the mandatory standard conditions of approval. Please note these and inform the HREC when the project is completed or if there are any changes of protocol.

Standard Conditions in accordance with the National Statement on Ethical Conduct in Human Research (National Statement) (NS).

1. Monitoring

   NS 5.5.1 – 5.5.10
   Responsibility for ensuring that research is reliably monitored lies with the institution under which the research is conducted. Mechanisms for monitoring can include:
   (a) reports from researchers;
   (b) reports from independent agencies (such as a data and safety monitoring board);
   (c) review of adverse event reports;
   (d) random inspections of research sites, data, or consent documentation; and
   (e) interviews with research participants or other forms of feedback from them.

   The following should be noted:
(a) All ethics approvals are valid for **12 months** unless specified otherwise. If research is continuing after 12 months, then the ethics approval MUST be renewed. Complete the Annual Report/Renewal form and send to the Secretary of the HREC.

(b) **NS 5.5.5**
Generally, the researcher/s provide a report every 12 months on the progress to date or outcome in the case of completed research specifically including:
- The maintenance and security of the records.
- Compliance with the approved proposal
- Compliance with any conditions of approval.
- Any changes of protocol to the research.

Note: Compliance to the reporting is mandatory to the approval of this research.

(c) Specifically, that the researchers report immediately and notify the HREC, in writing, for approval of any change in protocol. **NS 5.5.3**

(d) That a report is sent to HREC when the project has been completed.

(e) That the researchers report immediately any circumstance that might affect ethical acceptance of the research protocol. **NS 5.5.3**

(f) That the researchers report immediately any serious adverse events/effects on participants. **NS 5.5.3**

2. Research conducted overseas

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Complaints about the ethical conduct of this research should be addressed in writing to the following:

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Email: sue.kelly@scu.edu.au
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All participants in research conducted by Southern Cross University should be advised of the above procedure and be given a copy of the contact details for the Complaints Officer. They should also be aware of the ethics approval number issued by the Human Research Ethics Committee.

Sue Kelly
Secretary HREC
Ph: +61
+2 6626
9139
sue.kelly@scu.edu.au

Professor Bill Boyd
Chair, HREC
Ph: (02) 6620
3569
william.boyd@scu.edu.au
Food Technology, Innovation and Teacher Education Survey

What is the state of play in schools?

What is the state of play beyond schools?

What are the alignments and ideas for a common future?
Thank you for taking the time to fill out this survey.

The survey consists of 3 sections:
1. Demographics
2. Food Technology and General Education
3. Innovation, Food Technology and Education

*Please fill out the survey using a blue or black biro pen.

There are 33 items with 6 items being short answer responses.

The survey takes approximately 45 minutes to fill out.

*Please return the surveys (completed or uncompleted) in the reply paid envelope supplied no later than 2 months after initial receipt of the survey by you.

As a participant you will be included in a draw to win one of three Starcash vouchers.

**Voucher 1 - worth $100.00:** First drawn from the hat where the survey is fully completed and returned by the specified timeframe.

**Voucher 2 - worth $50.00:** Second drawn consolation voucher where the survey is fully completed and returned by the specified timeframe.

**Voucher 3 - worth $25.00:** Third drawn consolation voucher where the survey is fully completed and returned by the specified timeframe.
SECTION 1:

DEMOGRAPHICS
# About you

Your demographic, educational background and expertise is considered a valuable and relevant contribution in this survey. Please fill out these questions as best you can.

## Please circle the most relevant:

1: I am:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0101</td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>0102</td>
<td>Female</td>
<td></td>
</tr>
</tbody>
</table>

2: My age grouping is:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0201</td>
<td>20-29</td>
</tr>
<tr>
<td>0202</td>
<td>30-39</td>
</tr>
<tr>
<td>0203</td>
<td>40-49</td>
</tr>
<tr>
<td>0204</td>
<td>50-59</td>
</tr>
<tr>
<td>0205</td>
<td>60-69</td>
</tr>
<tr>
<td>0206</td>
<td>70+</td>
</tr>
</tbody>
</table>

3: I have been a teacher for:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0301</td>
<td>0 years/Undergrad</td>
</tr>
<tr>
<td>0302</td>
<td>1-4yrs</td>
</tr>
<tr>
<td>0303</td>
<td>5-10yrs</td>
</tr>
<tr>
<td>0304</td>
<td>11-15yrs</td>
</tr>
<tr>
<td>0305</td>
<td>16-20 yrs</td>
</tr>
<tr>
<td>0306</td>
<td>21-25yrs</td>
</tr>
<tr>
<td>0307</td>
<td>26-30yrs</td>
</tr>
<tr>
<td>0308</td>
<td>31-35yrs</td>
</tr>
<tr>
<td>0309</td>
<td>36+yrs</td>
</tr>
</tbody>
</table>

4: Most of my teaching employment has been:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0401</td>
<td>FT</td>
<td></td>
</tr>
<tr>
<td>0402</td>
<td>PT</td>
<td></td>
</tr>
<tr>
<td>0403</td>
<td>Casual</td>
<td></td>
</tr>
</tbody>
</table>
Education background

5: Did you complete or are you enrolled in a full degree?
   * NB: Normally a 3-4yr Degree
   0 No
   1 Yes (If yes, what is the name of your degree?)

6: Did you complete or are you enrolled in a TAFE/university combined qualification with a Food Technology focus?
   * NB: Non TAS may answer under ‘Other’
   0 No
   1 Yes (If yes, what is the name of your qualification?)
     • Other*

7: Did you complete or are you enrolled in a 4 year Technology* Education qualification with a Food major?
   * NB: May be called D&T, BTechEd or TAS with ‘NO’ TAFE embedded training
   Non-TAS may answer under ‘Other’
   1 Yes (If yes, what is the name of your qualification?)
   0 No (If no, go to number 9)
     • Other*

8: If you completed a Food Technology related university degree, were you aware of your lecturer’s qualification?
   0 No
   1 Yes (If yes, what was the area of expertise?)
General area of expertise

**9:** Circle in one of the numbered boxes below (and only one) which area you identify with the most as your area of expertise.

<table>
<thead>
<tr>
<th>GROUP A: Teacher Training (Food Technology)</th>
<th>GROUP B: Teacher Training (area other than Food Technology)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAE A1 Food Technology secondary teacher</td>
<td>GAE B1 TAS secondary teacher</td>
</tr>
<tr>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>GAE A2 Food Technology Academic</td>
<td>GAE B2 TAS Academic</td>
</tr>
<tr>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>GAE A3 Food Technology undergraduate student</td>
<td>GAE B3 TAS undergraduate student</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP C: Teacher Training (general secondary)</th>
<th>GROUP D: Non-Teacher Training (Food Technology)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAE C1 non-TAS secondary teacher</td>
<td>GAE D1 Food Technologist/Scientist</td>
</tr>
<tr>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>GAE C2 non-TAS Academic</td>
<td>GAE D2 Food Technology Academic</td>
</tr>
<tr>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>GAE C3 non-TAS undergraduate student</td>
<td>GAE D3 Food Science/Technology undergraduate student</td>
</tr>
</tbody>
</table>

* If you circled undergraduate please tick your year level:

1  2  3  4

* If you circled Food Technology secondary teacher, Food Technology Academic (teaching), TAS secondary teacher or TAS Academic go to number 10.

* If you circled Non-TAS secondary teacher or Non-TAS Academic go to number 11.

**All others go to number 12**
Number 10 and Number 11 example.

Now turn the page and fill out this question as per the example. Note that number 10 is for TAS teachers and number 11 is for NON TAS teachers.

<table>
<thead>
<tr>
<th>1</th>
<th>Original area of qualification prior to teaching qualification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>10101</td>
</tr>
<tr>
<td>Building Construction</td>
<td>10102</td>
</tr>
<tr>
<td>Computing Applications</td>
<td>10103</td>
</tr>
<tr>
<td>Carpentry Trade</td>
<td>10104</td>
</tr>
<tr>
<td>Electro technology</td>
<td>10105</td>
</tr>
<tr>
<td>Engineering Science</td>
<td>10106</td>
</tr>
<tr>
<td>Entertainment Industry</td>
<td>121201</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>10108</td>
</tr>
<tr>
<td>Food Technology</td>
<td>10109</td>
</tr>
<tr>
<td>Furniture Design</td>
<td>10110</td>
</tr>
<tr>
<td>Graphics Technology</td>
<td>10111</td>
</tr>
<tr>
<td>Hospitality</td>
<td>10112</td>
</tr>
<tr>
<td>Industrial Design</td>
<td>10113</td>
</tr>
<tr>
<td>Industrial Technology</td>
<td>12115</td>
</tr>
<tr>
<td>Information Processes and Technology</td>
<td>15115</td>
</tr>
<tr>
<td>Information Technology</td>
<td>15116</td>
</tr>
<tr>
<td>Primary Industry Studies</td>
<td>15117</td>
</tr>
<tr>
<td>Metal Fabrication Trade</td>
<td>12118</td>
</tr>
<tr>
<td>Software Design and Development</td>
<td>10118</td>
</tr>
<tr>
<td>Textiles/fashion Design</td>
<td>10120</td>
</tr>
<tr>
<td>Tourism</td>
<td>10121</td>
</tr>
<tr>
<td>Other:</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>TAS teacher qualification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>12001</td>
</tr>
<tr>
<td>Computing Applications</td>
<td>12002</td>
</tr>
<tr>
<td>Construction</td>
<td>12003</td>
</tr>
<tr>
<td>Design and Technology</td>
<td>10204</td>
</tr>
<tr>
<td>Electro technology</td>
<td>10205</td>
</tr>
<tr>
<td>Engineering Science</td>
<td>12006</td>
</tr>
<tr>
<td>Entertainment Industry</td>
<td>12007</td>
</tr>
<tr>
<td>Food Technology</td>
<td>12008</td>
</tr>
<tr>
<td>Furniture Design</td>
<td>12009</td>
</tr>
<tr>
<td>Graphics Technology</td>
<td>12010</td>
</tr>
<tr>
<td>Hospitality</td>
<td>12011</td>
</tr>
<tr>
<td>Industrial Technology</td>
<td>12012</td>
</tr>
<tr>
<td>Information Processes and Technology</td>
<td>12013</td>
</tr>
<tr>
<td>Information Technology</td>
<td>12014</td>
</tr>
<tr>
<td>Primary Industry Studies</td>
<td>12015</td>
</tr>
<tr>
<td>Marine Studies</td>
<td>12016</td>
</tr>
<tr>
<td>Metal and Engineering</td>
<td>12017</td>
</tr>
<tr>
<td>Software Design and Development</td>
<td>12018</td>
</tr>
<tr>
<td>Textiles/fashion Design</td>
<td>12019</td>
</tr>
<tr>
<td>Tourism</td>
<td>12020</td>
</tr>
<tr>
<td>Other:</td>
<td>-</td>
</tr>
<tr>
<td>Work and Workplace Training</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Other areas of Non TAS teaching you have been asked to teach that you were not trained in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting</td>
<td>10301</td>
</tr>
<tr>
<td>Aboriginal Studies</td>
<td>10302</td>
</tr>
<tr>
<td>Biology</td>
<td>10303</td>
</tr>
<tr>
<td>Business Studies</td>
<td>10304</td>
</tr>
<tr>
<td>Chemistry</td>
<td>10305</td>
</tr>
<tr>
<td>Commerce</td>
<td>10306</td>
</tr>
<tr>
<td>Community Family Studies</td>
<td>10307</td>
</tr>
<tr>
<td>Dance</td>
<td>10308</td>
</tr>
<tr>
<td>Drama</td>
<td>10309</td>
</tr>
<tr>
<td>Early Childhood</td>
<td>10310</td>
</tr>
<tr>
<td>Economics</td>
<td>10311</td>
</tr>
<tr>
<td>English</td>
<td>12011</td>
</tr>
<tr>
<td>Geography</td>
<td>12012</td>
</tr>
<tr>
<td>History</td>
<td>12013</td>
</tr>
<tr>
<td>Legal Studies</td>
<td>12014</td>
</tr>
<tr>
<td>Mathematics</td>
<td>12015</td>
</tr>
<tr>
<td>Music</td>
<td>12016</td>
</tr>
<tr>
<td>Other:</td>
<td>-</td>
</tr>
</tbody>
</table>
Area of qualification and teaching expertise:  
TAS teachers only

<table>
<thead>
<tr>
<th>1. Original area of qualification prior to teaching qualification.</th>
<th>2. TAS teacher qualification educated in.</th>
<th>3. Other areas of Non TAS teaching you have been asked to teach that you were not educated in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this column write the number 1 next to your original qualification and 2 next to any subsequent qualification in teaching, including VET</td>
<td>In this column write the number 1 next to your original qualification and 2 next to any subsequent qualification in teaching, including VET</td>
<td>In this column write the number 1 next to the most consistent area of teaching and the number 2 next to a subsequent area.</td>
</tr>
<tr>
<td>Agriculture 10101</td>
<td>Agriculture 10201</td>
<td>Accounting 10301</td>
</tr>
<tr>
<td>Building Construction 10102</td>
<td>Computing Applications 10202</td>
<td>Aboriginal Studies 10302</td>
</tr>
<tr>
<td>Computing Applications 10103</td>
<td>Construction 10203</td>
<td>Biology 10303</td>
</tr>
<tr>
<td>Carpentry Trade 10104</td>
<td>Design and Technology 10204</td>
<td>Business Studies 10304</td>
</tr>
<tr>
<td>Electro technology 10105</td>
<td>Electro technology 10205</td>
<td>Chemistry 10305</td>
</tr>
<tr>
<td>Engineering Science 10106</td>
<td>Engineering Science 10206</td>
<td>Commerce 10306</td>
</tr>
<tr>
<td>Entertainment Industry 10107</td>
<td>Entertainment Industry 10207</td>
<td>Community Family Studies 10307</td>
</tr>
<tr>
<td>Environmental Science 10108</td>
<td>Food Technology 10208</td>
<td>Dance 10308</td>
</tr>
<tr>
<td>Food Technology 10109</td>
<td>Furniture Design 10209</td>
<td>Drama 10309</td>
</tr>
<tr>
<td>Furniture Design 10110</td>
<td>Graphics Technology 10210</td>
<td>Early Childhood 10310</td>
</tr>
<tr>
<td>Graphics Technology 10111</td>
<td>Hospitality 10211</td>
<td>Economics 10311</td>
</tr>
<tr>
<td>Hospitality 10112</td>
<td>Industrial Technology 10212</td>
<td>English 10312</td>
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<tr>
<td>Industrial Design 10113</td>
<td>Information Processes and Technology 10213</td>
<td>Geography 10313</td>
</tr>
<tr>
<td>Industrial Technology 10114</td>
<td>Information Technology 10214</td>
<td>History 10314</td>
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<tr>
<td>Information Processes and Technology 10115</td>
<td>Primary Industry Studies 10215</td>
<td>Legal Studies 10315</td>
</tr>
<tr>
<td>Information Technology 10116</td>
<td>Marine Studies 10216</td>
<td>Mathematics 10316</td>
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<tr>
<td>Primary Industry Studies 10117</td>
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<tr>
<td>Metal Fabrication Trade 10118</td>
<td>Software Design and Development 10218</td>
<td>Sport Science 10318</td>
</tr>
<tr>
<td>Software Design and Development 10119</td>
<td>Textiles/fashion Design 10219</td>
<td>Science 10319</td>
</tr>
<tr>
<td>Textiles/fashion Design 10120</td>
<td>Tourism 10220</td>
<td>PDHPE 10320</td>
</tr>
<tr>
<td>Tourism 10121</td>
<td>10221</td>
<td>Physics 10321</td>
</tr>
<tr>
<td>Other: .</td>
<td>Other: .</td>
<td>Other: .</td>
</tr>
</tbody>
</table>

Other: Other: Other:
Area of qualification and teaching expertise:  
Non TAS teachers only

11:

<table>
<thead>
<tr>
<th>1. Original area of qualification prior to teaching qualification.</th>
<th>2. Non TAS teacher qualification educated in.</th>
<th>3. Area of TAS teaching you have been asked to teach that you were not educated in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this column write your knowledge area and level of qualification (i.e. field of 1st degree) * Leave blank if none</td>
<td>In this column write the number 1 next to your original qualification and 2 next to any subsequent qualification in teaching.</td>
<td>In this column write the number 1 next to the most consistent area of teaching and the number 2 next to a subsequent area where applicable.</td>
</tr>
<tr>
<td>Accounting</td>
<td>11201</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Aboriginal Studies</td>
<td>11202</td>
<td>Computing Applications</td>
</tr>
<tr>
<td>Biology</td>
<td>11203</td>
<td>Construction</td>
</tr>
<tr>
<td>Business Studies</td>
<td>11204</td>
<td>Design and Technology</td>
</tr>
<tr>
<td>Chemistry</td>
<td>11205</td>
<td>Electro technology</td>
</tr>
<tr>
<td>Commerce</td>
<td>11206</td>
<td>Engineering Science</td>
</tr>
<tr>
<td>Community and Family Studies</td>
<td>11207</td>
<td>Entertainment Industry</td>
</tr>
<tr>
<td>Dance</td>
<td>11208</td>
<td>Food Technology</td>
</tr>
<tr>
<td>Drama</td>
<td>11209</td>
<td>Furniture Design</td>
</tr>
<tr>
<td>Early Childhood</td>
<td>11210</td>
<td>Graphics Technology</td>
</tr>
<tr>
<td>Economics</td>
<td>11211</td>
<td>Hospitality</td>
</tr>
<tr>
<td>English</td>
<td>11212</td>
<td>Industrial Technology</td>
</tr>
<tr>
<td>Geography</td>
<td>11213</td>
<td>Information Processes and Technology</td>
</tr>
<tr>
<td>History</td>
<td>11214</td>
<td>Information Technology</td>
</tr>
<tr>
<td>Legal Studies</td>
<td>11215</td>
<td>Primary Industry Studies</td>
</tr>
<tr>
<td>Mathematics</td>
<td>11216</td>
<td>Marine Studies</td>
</tr>
<tr>
<td>Music</td>
<td>11217</td>
<td>Metal and Engineering</td>
</tr>
<tr>
<td>Sport Science</td>
<td>11218</td>
<td>Software Design and Development</td>
</tr>
<tr>
<td>Science</td>
<td>11219</td>
<td>Textiles/fashion Design</td>
</tr>
<tr>
<td>PDHPE</td>
<td>11220</td>
<td>Tourism</td>
</tr>
<tr>
<td>Physics</td>
<td>11221</td>
<td>Other:</td>
</tr>
<tr>
<td>Visual Art/Design</td>
<td>11222</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td>.</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 2:

FOOD TECHNOLOGY and GENERAL EDUCATION
Knowledge and techniques

At various times Food Technology has been described using the following phrases. In this part of the survey, I am interested in your perceptions about Food Technology. If you are not sure about some questions please answer with your best guess.

12: Circle up to 10 phrases that you have used or that best describe the knowledge and techniques used in Food Technology.

<table>
<thead>
<tr>
<th>Preservation and packaging</th>
<th>Food technology/Commerce management</th>
<th>Individual and family health</th>
<th>Engineering processes</th>
<th>Development of social skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>K&amp;T1201</td>
<td>K&amp;T1202</td>
<td>K&amp;T1203</td>
<td>K&amp;T1204</td>
<td>K&amp;T1205</td>
</tr>
<tr>
<td>Healthy eating</td>
<td></td>
<td>Research and science driven</td>
<td></td>
<td>Agriculture</td>
</tr>
<tr>
<td>K&amp;T1206</td>
<td></td>
<td></td>
<td></td>
<td>K&amp;T1210</td>
</tr>
<tr>
<td>Meal preparation and presentation skills</td>
<td>Applied management science</td>
<td>Epidemiology and biostatistics</td>
<td>Food biochemistry</td>
<td>Science experiments</td>
</tr>
<tr>
<td>K&amp;T1211</td>
<td>K&amp;T1212</td>
<td>K&amp;T1213</td>
<td>K&amp;T1214</td>
<td>K&amp;T1215</td>
</tr>
<tr>
<td>Microbiology</td>
<td>Meal and recipe planning</td>
<td>Cooking skills</td>
<td>Food processing and food process control systems</td>
<td>Front of house</td>
</tr>
<tr>
<td>K&amp;T1216</td>
<td>K&amp;T1217</td>
<td>K&amp;T1218</td>
<td>K&amp;T1219</td>
<td>K&amp;T1220</td>
</tr>
<tr>
<td>Quality assurance</td>
<td>Life skills</td>
<td>Chemistry</td>
<td>Back of house</td>
<td>Food service and catering</td>
</tr>
<tr>
<td>K&amp;T1221</td>
<td>K&amp;T1222</td>
<td>K&amp;T1223</td>
<td>K&amp;T1224</td>
<td>K&amp;T1225</td>
</tr>
</tbody>
</table>
# Tools and equipment

Food Technology uses various tools and equipment for different purposes. In this part of the survey, I am interested in your perceptions of what tools and equipment are used in Food Technology. If you are not sure about some questions please answer with your best guess.

### 13: Circle up to 10 items below that you have used or that best describe the tools and equipment used in Food Technology.

<table>
<thead>
<tr>
<th>Tools and Equipment</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic knife</td>
<td>TAE1301</td>
</tr>
<tr>
<td>Vacuum packaging machine</td>
<td>TAE1302</td>
</tr>
<tr>
<td>Garlic crusher</td>
<td>TAE1303</td>
</tr>
<tr>
<td>Wok</td>
<td>TAE1304</td>
</tr>
<tr>
<td>Parisienne scoop</td>
<td>TAE1305</td>
</tr>
<tr>
<td>Bowl cutter</td>
<td>TAE1306</td>
</tr>
<tr>
<td>Paring knife</td>
<td>TAE1307</td>
</tr>
<tr>
<td>Apple corer</td>
<td>TAE1308</td>
</tr>
<tr>
<td>Cheese slice</td>
<td>TAE1309</td>
</tr>
<tr>
<td>Pulse electric field processor</td>
<td>TAE1310</td>
</tr>
<tr>
<td>Evaporator</td>
<td>TAE1311</td>
</tr>
<tr>
<td>Autoclave</td>
<td>TAE1312</td>
</tr>
<tr>
<td>Ginger bread cookie cutter</td>
<td>TAE1313</td>
</tr>
<tr>
<td>Soufflé dish</td>
<td>TAE1314</td>
</tr>
<tr>
<td>Muffin tray</td>
<td>TAE1315</td>
</tr>
<tr>
<td>Potato masher</td>
<td>TAE1316</td>
</tr>
<tr>
<td>Pastry brush</td>
<td>TAE1317</td>
</tr>
<tr>
<td>Glass Beakers</td>
<td>TAE1318</td>
</tr>
<tr>
<td>Freeze dryer</td>
<td>TAE1319</td>
</tr>
<tr>
<td>Thermometer</td>
<td>TAE1320</td>
</tr>
<tr>
<td>Bandsaw</td>
<td>TAE1321</td>
</tr>
<tr>
<td>Piping bag</td>
<td>TAE1322</td>
</tr>
<tr>
<td>Test tubes</td>
<td>TAE1323</td>
</tr>
<tr>
<td>Novelty cake tin</td>
<td>TAE1324</td>
</tr>
<tr>
<td>Microscope</td>
<td>TAE1325</td>
</tr>
</tbody>
</table>
Materials and ingredients

Food Technology uses various materials and ingredients for different purposes. I am interested in your perceptions of what materials and ingredients are used in Food Technology. If you are not sure about some questions please answer with your best guess.

14: Circle up to 10 items below that you have used or best describe the ingredients used in Food Technology.

<table>
<thead>
<tr>
<th>Tomato paste</th>
<th>Basil</th>
<th>Full cream milk</th>
<th>Bioactives</th>
<th>Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>M&amp;I1401</td>
<td>M&amp;I1402</td>
<td>M&amp;I1403</td>
<td>M&amp;I1404</td>
<td>M&amp;I1405</td>
</tr>
<tr>
<td>Milk solids</td>
<td>Fresh eggs</td>
<td>Folic acid</td>
<td>Minced meat</td>
<td>Vegetable gum</td>
</tr>
<tr>
<td>M&amp;I1406</td>
<td>M&amp;I1407</td>
<td>M&amp;I1408</td>
<td>M&amp;I1409</td>
<td>M&amp;I1410</td>
</tr>
<tr>
<td>Onions</td>
<td>Sulphites</td>
<td>Fillet steak</td>
<td>Parsley</td>
<td>Lysozyme</td>
</tr>
<tr>
<td>M&amp;I1411</td>
<td>M&amp;I1412</td>
<td>M&amp;I1413</td>
<td>M&amp;I1414</td>
<td>M&amp;I1415</td>
</tr>
<tr>
<td>Glycerol</td>
<td>Rice</td>
<td>Ribonucleotides</td>
<td>Glycinin</td>
<td>Garlic</td>
</tr>
<tr>
<td>M&amp;I1416</td>
<td>M&amp;I1417</td>
<td>M&amp;I1418</td>
<td>M&amp;I1419</td>
<td>M&amp;I1420</td>
</tr>
<tr>
<td>Lactic acid bacteria</td>
<td>Hydrolysed vegetable protein</td>
<td>Capsicum</td>
<td>Benzoic acid</td>
<td>Pine nuts</td>
</tr>
<tr>
<td>M&amp;I1421</td>
<td>M&amp;I1422</td>
<td>M&amp;I1423</td>
<td>M&amp;I1424</td>
<td>M&amp;I1425</td>
</tr>
</tbody>
</table>
Food Technology as an area of study

15: For each statement below please indicate your rating by ticking one box for each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Office Use only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Food Technology study offers a relevant pathway into Hospitality industries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 01</td>
</tr>
<tr>
<td>In my opinion, Food Technology 7-10 is about learning self-sustainable life skills such as practical cooking lessons.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 02</td>
</tr>
<tr>
<td>Students take Food Technology as an area of study in Stage 6 because they want a career as a food technologist/scientist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 03</td>
</tr>
<tr>
<td>Eco sustainability, synthetic foods, naturopathy, bush food nutrition and associated food product innovations and business enterprise should be core areas of study in the 7-12 Food Technology syllabi.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 04</td>
</tr>
<tr>
<td>Controlled research and hypothesis testing is not likely to be useful for secondary Food Technology students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 05</td>
</tr>
<tr>
<td>Students at this school study Food Technology in years 11 and 12.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 06</td>
</tr>
<tr>
<td>Associated school syllabus textbooks and magazines are often more useful than research based journals for the study of Food Technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 07</td>
</tr>
<tr>
<td>School students choose Food Technology as an area of study in years 11 and 12 because they want a career as a secondary Food Technology teacher.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 08</td>
</tr>
<tr>
<td>Food Technology years 7-12 should include creative graphic design applications such as CAD (Computer Aided Design).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 09</td>
</tr>
<tr>
<td>It’s just as important for Food Technology students to undertake experiments as it is for students studying chemistry and biology in secondary schools.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 10</td>
</tr>
<tr>
<td>I am aware of the National Food Industry Study undertaken in 2003.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 11</td>
</tr>
<tr>
<td>The Food Technology Syllabus years 11 and 12 provides an excellent foundation of learning for industry related undergraduate study for Food Science and Technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 12</td>
</tr>
<tr>
<td>It is important for students to have a sound knowledge base in controlled research and hypothesis testing to study Food Technology at a secondary and undergraduate level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 13</td>
</tr>
<tr>
<td>Students need to demonstrate strong science and maths skills to study Food Technology at a secondary school and teacher training level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FAOS15 14</td>
</tr>
</tbody>
</table>
### Expectations or experiences

This part of the survey is intended to provide information regarding your expectations and experiences for some aspects of teaching. Remember that the survey is not assessing individuals, but rather seeks to explore general group trends.

Indicate your rating by placing a ✓ inside the box that best describes your agreement with the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>16: Drawing and mental visualisation tasks would enhance the study of Food Technology.</td>
<td>1: Strongly Disagree, 2: Disagree, 4: Agree, 5: Strongly Agree</td>
</tr>
<tr>
<td>17: Computer Aided Design (CAD) has a place in the teaching and learning of Food Technology tasks.</td>
<td>1: Strongly Disagree, 2: Disagree, 4: Agree, 5: Strongly Agree</td>
</tr>
<tr>
<td>18: It is easy to integrate Information Communication Technology (ICT) skills into lessons.</td>
<td>1: Strongly Disagree, 2: Disagree, 4: Agree, 5: Strongly Agree</td>
</tr>
<tr>
<td>19: The FOODWORX CD sent out to all secondary and tertiary education sectors during 2004 proved to be a useful teaching resource.</td>
<td>1: Strongly Disagree, 2: Disagree, 4: Agree, 5: Strongly Agree</td>
</tr>
<tr>
<td>20: Conferences are regular items I track in my diary.</td>
<td>1: Strongly Disagree, 2: Disagree, 4: Agree, 5: Strongly Agree</td>
</tr>
</tbody>
</table>
Expectations or experiences

Place a ✓ inside one box (and one box only) that you feel is the most relevant.

21: (a) Do you feel that you have sufficient access to professional development? For example, development provided by food scientists and technologists.

✓ YES  ☐ NO

(b) If yes, how often would you update your knowledge and skills from a food science and technologists workshop?

____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________

(c) If no, or you are not a Food Technology teacher, state what type (s) of professional development you would like to receive.

____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________
Expectations or experiences

Place a ✓ inside one box (and one box only) that you feel is the most relevant.

22: For each phrase below indicate your rating by ticking one box for the following statement:

_It is difficult to explore new ways of learning due to:_

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Office use only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fear of failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time constraints</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffroom culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of control of the student learning environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing the teaching process when using new knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disinterested colleagues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A lack of resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A lack of confidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate in-service training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please list any other difficulties you may have that are not listed above:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
Food Technology as a scholarly subject choice

23: Provide a ranking out of ten (10) for each of the following Stage 6 subjects. Where 10 = highest scholarly ranking and 1 = lowest scholarly ranking. Please rank all subjects.

______Business Studies
______Chemistry
______Dance
______Drama
______English
______Food Technology
______Geography
______History
______Industrial Technology
______Mathematics
______Music
______PDHPE (Personal Development, Health and Physical Education)
______Physics
______Science
______Visual Art
Food Technology and general education

24: Why should Food Technology be taught in secondary schools?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

25: Most of the 7-10 TAS syllabi were accompanied with advice that “some/many existing units of work will form the bases of effective programs” (A Guide to the New Years 7-8 and 7-10 syllabus: Board of Studies, 2003, p. 1). What is your reaction to this?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

26: What sources do you draw knowledge from for understanding of the topic you are teaching?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
SECTION 3:

INNOVATION, FOOD TECHNOLOGY and TECHNOLOGY EDUCATION
At various times learner attributes have been described using the following phrases. In this part of the survey, I am interested in your views on assessable learner attributes. Remember that you are not being assessed personally, but I need to find out about general group trends in these answers.

27: Circle up to 10 phrases that you think best describe the attributes you feel are important to foster in students.

<table>
<thead>
<tr>
<th>Good behaviour</th>
<th>Follow a formula for success</th>
<th>Imaginative, enterprising and resourceful</th>
<th>Stability and good habits through practice</th>
<th>Awareness, and how to knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA2701</td>
<td>LA2702</td>
<td>LA2703</td>
<td>LA2704</td>
<td>LA2705</td>
</tr>
<tr>
<td>Entrepreneur skills</td>
<td>Apply design principles as a chaotic process</td>
<td>LA2706</td>
<td>LA2707</td>
<td>LA2708</td>
</tr>
<tr>
<td>Individuality and self needs</td>
<td>Technical precision</td>
<td>LA2711</td>
<td>LA2712</td>
<td>LA2713</td>
</tr>
<tr>
<td>Repetitive skill tasks to perfect a finished product</td>
<td>Remain motivated when faced with difficult circumstances</td>
<td>LA2716</td>
<td>LA2717</td>
<td>LA2718</td>
</tr>
<tr>
<td>Persevere through trial and error processes</td>
<td>Safe use of tools and equipment</td>
<td>LA2721</td>
<td>LA2722</td>
<td>LA2723</td>
</tr>
</tbody>
</table>
## Innovation as an area of study

**28:** For each statement below please indicate your rating by ticking one box for each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A standard classification scheme is needed so that innovation attributes can be described in universal terms of stages of development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The skills shortage concerns equipment / trade labour skills.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 01</td>
</tr>
<tr>
<td>The making of a product is more beneficial to students than the study of innovation and designing.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 02</td>
</tr>
<tr>
<td>To be considered an innovation a product/system has to find success in the market place.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 03</td>
</tr>
<tr>
<td>Students can be taught to be creative and innovative.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 04</td>
</tr>
<tr>
<td>Food product innovations change too often to be able to study in much depth.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 05</td>
</tr>
<tr>
<td>The Food Technology Syllabi foster attributes needed in the modern economy.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 06</td>
</tr>
<tr>
<td>It is important to teach skills first in order for students to be able to design.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 07</td>
</tr>
<tr>
<td>Innovation is a myth pushed by academics.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 08</td>
</tr>
<tr>
<td>The study of technology and innovation primarily focuses around making things.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 09</td>
</tr>
<tr>
<td>Acceptability research is important for positioning a product.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 10</td>
</tr>
<tr>
<td>Invention and innovation mean the same thing.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 11</td>
</tr>
<tr>
<td>Lack of equipment is a hindrance for teaching innovation.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 12</td>
</tr>
<tr>
<td>It is important to link general principles with specific experiences.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 13</td>
</tr>
<tr>
<td>The knowledge economy is not very relevant to students for jobs.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 14</td>
</tr>
<tr>
<td>Technological change occurs at such a fast rate it is too complex to study.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 15</td>
</tr>
<tr>
<td>Designing is highly valued at this educational institution.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 16</td>
</tr>
<tr>
<td>Creativity is the same as being innovative.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 17</td>
</tr>
<tr>
<td>The skills shortage mainly concerns the professions of science / medical / engineering and maths.</td>
<td></td>
<td></td>
<td></td>
<td>IAOS28 18</td>
</tr>
</tbody>
</table>
29: Provide a ranking out of ten (10) for each the following attributes in order of importance. Where 10 = most important and 1 = least important.

*Please rank all subjects.*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical skills</td>
<td>ASS2901</td>
</tr>
<tr>
<td>Learning new knowledge</td>
<td>ASS2902</td>
</tr>
<tr>
<td>Consideration of contexts</td>
<td>ASS2903</td>
</tr>
<tr>
<td>Follow a recipe, drawing plan or manual</td>
<td>ASS2904</td>
</tr>
<tr>
<td>Repetitive skill acquisition</td>
<td>ASS2905</td>
</tr>
<tr>
<td>Task purpose analysis</td>
<td>ASS2906</td>
</tr>
<tr>
<td>Good behaviour</td>
<td>ASS2907</td>
</tr>
<tr>
<td>Finished product</td>
<td>ASS2908</td>
</tr>
<tr>
<td>Innovative idea and application</td>
<td>ASS2909</td>
</tr>
<tr>
<td>Cognitive skills</td>
<td>ASS2910</td>
</tr>
<tr>
<td>OH&amp;S</td>
<td>ASS2911</td>
</tr>
<tr>
<td>Exam</td>
<td>ASS2912</td>
</tr>
<tr>
<td>Methodical</td>
<td>ASS2913</td>
</tr>
<tr>
<td>Collaborative skills</td>
<td>ASS2914</td>
</tr>
<tr>
<td>Critical reflection</td>
<td>ASS2915</td>
</tr>
</tbody>
</table>
Assessment

Indicate your rating by placing a ✓ inside the box that best describes your agreement with the following statement.

30: It is easy to assess innovation attributes in students.

[ ] YES  [ ] NO

(a) If yes, please provide indicators or attributes of what you look for in a student.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(b) If no, please list reasons why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
## Education and the economy

For each phrase below indicate your rating by ticking one box for the following question:

31: What do you see as the most important ‘generic skills’ a high school graduate requires in the current and emerging Australian economy?

<table>
<thead>
<tr>
<th>Skill and application in one area of manufacturing</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Office use only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptable to change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3101</td>
</tr>
<tr>
<td>Skilled artisan or technician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3102</td>
</tr>
<tr>
<td>Capacity for technical applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3103</td>
</tr>
<tr>
<td>Able to remain motivated when faced with difficult situations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3104</td>
</tr>
<tr>
<td>Think originally and critically</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3105</td>
</tr>
<tr>
<td>Creative individuals able to communicate well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3106</td>
</tr>
<tr>
<td>Experience in an area of expertise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3107</td>
</tr>
<tr>
<td>Capable of finding solutions to problems as they occur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3108</td>
</tr>
<tr>
<td>Capacity for abstract thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E&amp;E3110</td>
</tr>
</tbody>
</table>
Education and the economy

32: Tick in the boxes provided below any government “innovation” policies or reports in education and business that you may be aware of. Feel free to add other policies you may know of that are not listed below in ‘other’.

- No, I cannot recall any at the moment

<table>
<thead>
<tr>
<th>Policy</th>
<th>Reference</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commonwealth, &amp; Australia. (1999). Measuring the knowledge-based</td>
<td>Outcomes of the study: matching science and technology to future needs</td>
<td>201</td>
</tr>
<tr>
<td>economy: How does Australia compare?</td>
<td>2010.</td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>MCEETYA. (2000). Ministers joint statement on education and training</td>
<td></td>
<td>202</td>
</tr>
<tr>
<td>in the information economy.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>times, critical directions.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>Department, Education, &amp; Training. (2001). Environmental education</td>
<td></td>
<td>205</td>
</tr>
<tr>
<td>policy for schools.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>Department, Education, Training, Youth, &amp; Affairs. (2000). The way</td>
<td></td>
<td>206</td>
</tr>
<tr>
<td>forward: Higher education action plan for the information economy</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>teachers, Australia’s future. Advancing innovation, science, technology</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>and mathematics.</td>
<td></td>
<td>208</td>
</tr>
<tr>
<td>technologies for building and transforming Australian industries.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>KPA. (2003). National food industry study: Stocktake of education and</td>
<td></td>
<td>210</td>
</tr>
<tr>
<td>training related to Australian food.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>of schooling in Australia.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
<tr>
<td>summit: Final report.</td>
<td></td>
<td>E&amp;E3</td>
</tr>
</tbody>
</table>

- Other

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
33: **BRAIN BENDER**

Feel free to write your reaction to the following statement:

Knowledge, abstract thinking and vivid imagery are essential for excellence in skill development and should be given much more attention in learning and assessment in Technology subjects.
END OF SURVEY

Please check that you have answered every question and that pages have not been accidentally missed!

Thank you for your valued contribution to this survey.
Appendix 2
Science Vs Technology
Science Vs Technology
Ways of Knowing

Science
- focusses on the ethical process of gathering data
- is not directly accountable for what people do with findings
- seeks to control the context variables.
- analyses to understand parts, (breaks reality up in bits)
- knowing is by testing one idea against an alternative (method of idea refutation)

Technology
- focusses on the ethical effect of taking action
- is directly accountable for its designs, now & later
- seeks to accommodate the context variables.
- synthesises to understand whole (integrates parts to create new realities)
- Knowing is by testing/or simulating if one idea works against key purpose & context criteria (method of best-fit contestation)

Appendix 3

Techné versus Poiesis
TABLE I
Techné/poiesis tension

<table>
<thead>
<tr>
<th>Techné</th>
<th>Poiesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>Philosophical</td>
</tr>
<tr>
<td>Technical</td>
<td>Artistic</td>
</tr>
<tr>
<td>Technician</td>
<td>Artisan</td>
</tr>
<tr>
<td>More associated with skills associated</td>
<td>More associated with skills associated</td>
</tr>
<tr>
<td>with the body</td>
<td>with the mind</td>
</tr>
<tr>
<td>Vocational/Occupational</td>
<td>Academic</td>
</tr>
<tr>
<td>Technology is narrow and instrumental</td>
<td>Technology is broad and is a social</td>
</tr>
<tr>
<td></td>
<td>construction</td>
</tr>
<tr>
<td>Solo activity, individual, individual</td>
<td>Social process, collective, socially</td>
</tr>
<tr>
<td>centred</td>
<td>negotiated</td>
</tr>
<tr>
<td>Cognition is internalised and private</td>
<td>Cognition is distributed between the internal</td>
</tr>
<tr>
<td></td>
<td>and the external</td>
</tr>
<tr>
<td>Skills are transferred from expert to</td>
<td>Skills are negotiated and learning is</td>
</tr>
<tr>
<td>novice</td>
<td>mediated</td>
</tr>
</tbody>
</table>
Appendix 4

Manual training; manual arts; industrial arts
<table>
<thead>
<tr>
<th>MANUAL TRAINING</th>
<th>MANUAL ARTS</th>
<th>INDUSTRIAL ARTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inception: 1876</td>
<td>1896</td>
<td>1910</td>
</tr>
<tr>
<td>Influence: Della</td>
<td>Bennett, Vos, Runkle,</td>
<td>Bonser, Woodward,</td>
</tr>
<tr>
<td></td>
<td>Salomon,</td>
<td>Bigelow Griffith</td>
</tr>
<tr>
<td>Skill: Artisan</td>
<td>Craft basis,</td>
<td>Individual basis,</td>
</tr>
<tr>
<td>basis, Tool</td>
<td>&quot;Technics&quot;</td>
<td>&quot;Development&quot;</td>
</tr>
<tr>
<td>mastery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methods: Dictated</td>
<td>Assignment of</td>
<td>Projects and</td>
</tr>
<tr>
<td>exercises</td>
<td>useful artistic</td>
<td>individual creativity</td>
</tr>
<tr>
<td>Content largely:</td>
<td>Arts: Graphic,</td>
<td>Any representation</td>
</tr>
<tr>
<td>Work in wood;</td>
<td>Plastic, Textile,</td>
<td>of modern industry</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Mechanic, Book-</td>
<td>conditioned by</td>
</tr>
<tr>
<td>drawing</td>
<td>making</td>
<td>stated objectives</td>
</tr>
<tr>
<td>End functioning:</td>
<td>Avocational, nice</td>
<td>Exploration,</td>
</tr>
<tr>
<td>In itself</td>
<td>to have done, development of</td>
<td>Development of</td>
</tr>
<tr>
<td></td>
<td>appreciation for</td>
<td>Personal-social</td>
</tr>
<tr>
<td></td>
<td>the Crafts</td>
<td>Traits, Guidance,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consumer Education</td>
</tr>
</tbody>
</table>
| Basis of Truth:  | Authority and Scientific evi-
| Authority        | Custom         | dence and Criteria |
| Centers in Teacher | Centers in Project | Centers in Pupil |
| Unit-Shop        | Unit or General- | LABORATORY OF |
|                  | shop           | INDUSTRIES or |
|                  |                | Unit-shop      |
Appendix 5

Course of instruction for Domestic Science 1912

Home Economics syllabus 1952
Superior Public (Day Continuation) Schools.

Course of Instruction for Domestic Science Schools.

<table>
<thead>
<tr>
<th>Time Periods</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English</td>
</tr>
<tr>
<td></td>
<td>Household Accounts</td>
</tr>
<tr>
<td></td>
<td>Geography</td>
</tr>
<tr>
<td></td>
<td>Cookery and Laundry</td>
</tr>
<tr>
<td></td>
<td>Dressmaking and Millinery</td>
</tr>
<tr>
<td></td>
<td>Home Management</td>
</tr>
<tr>
<td></td>
<td>Hygiene, care of Infants and of the Sick</td>
</tr>
<tr>
<td></td>
<td>Botany and Gardening</td>
</tr>
<tr>
<td></td>
<td>Business Lessons</td>
</tr>
<tr>
<td></td>
<td>Morals and Civics (including History and Scripture)</td>
</tr>
<tr>
<td></td>
<td>Art and Home Decoration</td>
</tr>
<tr>
<td></td>
<td>Music and Social Exercises</td>
</tr>
<tr>
<td></td>
<td>Physical Training and Organised Games</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

Note.—1. Each day the pupils should devote one of the lesson periods specified above to private study under the general direction of the teacher.

2. Home lessons should not occupy more than one and a half hours per night for pupils of ordinary capacity. No formal home work should be set for Wednesday evenings.
NEW SOUTH WALES
DEPARTMENT OF EDUCATION

SYLLABUS IN HOME ECONOMICS

Prepared for use in High, Secondary, and other schools following the
High School Course.

Published with the authority of the Hon. R. J. Heffron, M.L.A., Minister
for Education, on the recommendation of the Board of Secondary School
Studies.

Revised August, 1952.

The Intermediate Course is divided into two main sections—

A. Nutrition and Food Preparation.
B. Housewifery with sub-sections, viz., Home Management,
   Business of the Household, Laundry.

The Leaving Certificate Course is divided into—

A. Principles of Nutrition.
B. Food Preparation.
C. Housewifery with concentration on two aspects—
   (a) Principles of Domestic Hygiene;
   (b) Principles of Laundry.

Throughout the syllabus from First to Fifth Years, the basic
science which is essential for the thorough understanding of the subject
matter has been clearly indicated. In order that the contents of
the syllabus may be correlated with the scientific principles involved,
it is advisable that this part of the course be carried out in the Science
room by either a member of the Home Economics staff or a member
of the Science staff.

This syllabus aims to train the pupil for future home-making. It
must, therefore, include instruction in the principles of food prepara-
tion and nutrition and in housewifery and domestic hygiene. Through
her experience in school, the pupil should develop a lively apprecia-
tion of the importance of living under proper conditions.

In practical work the teacher must aim at cultivating self-reliance
and independence in her pupils, since the development of these powers
through experience and experiment is more important than the im-
mediate practical results.

Every opportunity should be taken throughout the course to stress
personal hygiene.

The work of this course should be closely related to everyday
experience. It is recommended, therefore, that normal household
routine and experience rather than isolated topics be made the basis
of instruction.

The syllabus lends itself to the all-round developments of the girl
and to the correlation of many of her other studies in training for
citizenship. Within the Home Economics classroom endless oppor-
tunities are to be found for the inculcation (impression, development)
of right ideals of civic, moral and social conduct.

This syllabus does not necessarily indicate the sequence in which
sections should be taught nor the sequence of sub-sections.
Appendix 6

NSW high school framework for food technology
Hospitality Framework

The study of Food Technology provides students with a broad knowledge and understanding of food properties, processing, preparation and their interrelationships, nutritional considerations and consumption patterns. It addresses the importance of hygiene and safe working practices and legislation in the production of food. It also provides students with a context through which to explore the richness, pleasure and variety food adds to life. Students develop practical skills in preparing and presenting food that will enable them to select and use appropriate ingredients, methods and equipment.

This course provides for the development of relevant and meaningful learning experiences, inclusive of life experiences, values, learning styles and individual student characteristics. Through a study of food and its applications in domestic, commercial, industrial and global settings, the syllabus caters for all students' needs and interests. It contributes to both vocational and general life experiences. Integral to this syllabus is the ability to design, produce and evaluate solutions to situations involving food.

The aim of the Food Technology Syllabus is to actively engage students in learning about food in a variety of settings, enabling them to evaluate the relationships between food, technology, nutritional status and the quality of life. Students will develop confidence and proficiency in their practical interactions with and decisions regarding food.
Appendix 7

Foodworx CD
CAREERS IN FOOD SCIENCE

see
www.aifst.asn.au/foodworx
for further information
on Food Science Careers
Appendix 8

Innovation summary statement comparison table
<table>
<thead>
<tr>
<th>Summary statements</th>
<th>Likert Scale questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching pedagogy and assessment frameworks in education</td>
<td>A standard classification scheme is needed so that innovation attributes can be described in universal terms of stages of development.</td>
</tr>
</tbody>
</table>
| • The changing nature of technology  
• Media influence, public opinion and global reality for skills, trades or professions | The skills shortage concerns equipment / trade labour skills. |
| Perceptions of design as a creative enterprise | The making of a product is more beneficial to students than the study of innovation and designing. |
| Perceptions of innovation as economic enterprise | To be considered an innovation a product/system has to find success in the market place. |
| Perceptions of design as a creative enterprise | Students can be taught to be creative and innovative. |
| Educator willingness to teach design and innovation as a discipline | Food product innovations change too often to be able to study in much depth. |
| Perceptions of innovation as economic enterprise | The Food Technology Syllabi foster attributes needed in the modern economy. |
| Perceptions of design as a creative enterprise | It is important to teach skills first in order for students to be able to design. |
| Perceptions of innovation as economic enterprise | Innovation is a myth pushed by academics. |
| Perceptions of design as a creative enterprise | The study of technology and innovation primarily focuses around making things. |
| Perceptions of innovation as economic enterprise | Acceptability research is important for positioning a product. |
| Perceptions of innovation as economic enterprise | Invention and innovation mean the same thing. |
| Sustainability of vocational education | Lack of equipment is a hindrance for teaching innovation |
| Teaching pedagogy and assessment frameworks in education | It is important to link general principles with specific experiences. |
| Educator willingness to teach design and innovation as a discipline | The knowledge economy is not very relevant to students for jobs. |
| The changing nature of technology | Technological change occurs at such a fast rate it is too complex to study. |
| Perceptions of design as a creative enterprise | Designing is highly valued at this educational institution. |
| • Perceptions of design as a creative enterprise  
• Perceptions of innovation as economic enterprise | Creativity is the same as being innovative. |
| Media influence, public opinion and global reality for skills, trades or professions | The skills shortage mainly concerns the professions of science / medical / Engineering and maths. |