The EOTC milieu as a setting for teaching and learning experiences for five-year-old students in Technology Education

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Abstract

Technology Education has been a compulsory subject in the New Zealand primary school curriculum since 1999. Expert knowledge and practice in technology is important in the development of students' technological knowledge. Whilst this may be acquired within the classroom, this study argues for, and investigates the viewpoint, that its achievement can be enhanced through education outside the classroom (EOTC).

Within New Zealand school culture there is general agreement that education outside the classroom is inherently good and impacts positively on student learning. However, there is a paucity of literature available on theorising or practice in integrating EOTC and curriculum-based teaching and learning in technology education. This study focuses on five-year-old students undertaking a technology unit that incorporated an experience outside the classroom of technological practice, which was designed to inform students' classroom practice.

This research comprised a qualitative, case-study approach. Two classes of five year old students participated in a technology unit during which they visited a chocolate factory and investigated how to make chocolates for a Mothers' Day gift. This context, and the nature and age-group of the participants, drew on an examination of literature from three distinct domains: Technology Education, EOTC and the nature and characteristics of five-year-old students. The literature provided principles that underpinned a planning framework that was co-constructed between myself and the two teachers of the new entrant classes. Over a six month period, data was gathered during three phases of the study: (i) preparation in the technology unit for the visit outside the classroom, (ii) the visit to the chocolate factory and subsequent development of the chocolate gift in the classroom; and (iii) exploring enduring understandings resulting from the visit within the context of the unit. Data was gathered through a series of interviews with students and their teachers, observations and analysis of student work.

The findings indicated that an EOTC visit integrated into a technology unit can enhance student learning by making links between the classroom and the real

world, providing memorable experiences which students can transfer to new and varied contexts. These experiences were shown to develop context-specific language, understanding of technological process and equipment, and some understanding of material properties. These gains were shown to be most likely when supported by pre-visit scaffolding and post-visit reinforcement. A finding of additional significance was the key role that the parent-helpers played during the unit, visit and in student learning, and the importance of having a shared understanding of the teaching and learning goals of the technology project.

Whilst the study confirms young students' abilities to transfer technological understandings from one context to another, it also highlights the parameters of five-year-old student knowledge in technology education, brought about by their lack of practical experience and their limited knowledge of materials and material properties. This has implications for the level of support and guidance which is offered by the classroom teacher, and the time provided for students to informally experiment and become familiar with the properties of a range of different materials.

Dedication

This thesis is dedicated, in loving memory, to my Father (Joseph Thomas Lyle) and my Mother (Beryl Doris Lyle QSM), who would have derived great pleasure in celebrating the completion of this study.

Acknowledgments

"No matter what accomplishments you achieve, somebody helps you"
(A. Gibson, n.d.).

This thesis would not have been possible without the support of a number of people. I would like to firstly acknowledge the co-operation of the two schools involved in my research. I sincerely thank the principals, teachers, students and family members from each of these schools. The teachers were enthusiastic, and generous with their time, and the students were a delight to work with.

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Finally, I am indebted to the support and guidance of my Chief supervisor, Dr Chris Eames who steered me through this project with patience, expertise and good humour. He has enabled me to develop my research interests through this study and facilitated extensive personal and academic growth. I am also grateful for the knowledge and experience of my second supervisor Professor John Williams who asked many deep and difficult questions but also injected good doses of humour into his feedback. Thank you both for negotiating the challenges of being a colleague, a friend and a supervisor with such understanding.

Preface

James and his class visit to the science museum

Six year old James trudged through my doorway with his Mother and baby sister after a busy day at school. His class had visited the local science museum, and the anticipation of the visit had been building for some days. The weather was fine, the parent helpers had all arrived and expectations for an exciting visit were high. The glum look on his small face was my first indication that all was not well.

"How was your day James?" I asked. He shrugged his shoulders but did not reply.

"Did you have a good time?" I tried again.

"Not good," he replied. "Not good – too much walking – walk, walk, walk!"

"Really! Why was that?" This was not what I had expected.

"Too far to walk and the mothers got mad and some of the babies started to cry." He wandered off and my attempts to engage in further conversation went unheeded.

I tried again two days later.

"So why did you go to the museum with your class James?" Again the shrugging shoulders.

"Did you have something special to find out about?" He shook his head, looked uninterested and returned to building a windmill with the Lego.

"Not good," I agreed.

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Publications

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Chapter 1
Introduction and Background

1.1 Technology Education in the New Entrant classroom

This chapter provides a rationale for my research into the merger of Technology Education and Education Outside the Classroom (EOTC). Technology Education is one of eight learning areas in the New Zealand curriculum and a key element of this learning area requires students to “examine the practice of others and undertake their own” (Ministry of Education, 2007b, p. 32). An effective way of achieving this should be to provide students with the opportunity to experience expert practice within an authentic context – to encounter the noise, the smells and the real world environments, as well as to gain knowledge of the products which result from that practice. Gaining first-hand experience and knowledge within this type of environment, guided by experts, is likely to provide an experience which is both well informed and memorable.

My personal interest lies with the teaching and learning of five-year-old students, (also known in New Zealand as New Entrants), generally in their first year of formal schooling. Whilst there is a growing body of research in the area of Education Outside the Classroom and in Technology Education, nationally and internationally, there is little that combines these areas with the study of the five-year-old student. With this apparent gap in educational research, this study presents an intervention model – a planning framework, co-constructed with the research teachers, which supported the planning and teaching of a technology unit, and which incorporated a visit outside the classroom.

The potential benefits offered to students through participating in EOTC are considerable (D. Anderson, Lucas, & Ginns, 2003; Falk & Adelman, 2003; Falk & Dierking, 2000). A key advantage is where an experience is ‘novel’ i.e. it is new and of high interest and students participate with some prior knowledge of the event. The detail of these occurrences can be recalled with surprising clarity by quite young children, although their perceptions are naturally mediated by the knowledge and experience they bring to the task (D. Anderson, Thomas, & Ellenbogen, 2003).

Research suggests that an EOTC experience within any learning area is best considered in three phases of planning – before the visit, during the visit and after the visit (D. Anderson, Lucas, Ginns, & Dierking, 2000; Bolstad, 2000; Rennie & McClafferty, 1996). Each phase needs to consider the management and requirements not only of the students, but also the parent-helpers and the site presenters, as each has a role to play in the success of the visit and the resulting technological practice of the students.

1.2 Personal background of the researcher

My interest in pursuing this study had its beginnings in 2002, when an opportunity was presented to take part in a Ministry of Education programme which prepared practicing teachers to introduce the new Technology Education curriculum to primary and secondary teachers of technology (Ministry of Education, 1995). This led to many new opportunities, one of which was a first step into formal research and my completion of a Master of Education degree through the University of Waikato. In this project I investigated the planning and management of Technology Education in the New Entrant classroom, along with the design thinking and capabilities of these younger students. During the following years, this research offered significant benefits to me in my role as a lecturer in the Faculty of Education, University of Waikato, and enabled me to speak with greater authority on the practice of five-year-old students working within the technology curriculum. I now frequently repeat the comment "never underestimate the capabilities of our youngest students" when colleagues express disbelief at what these students are capable of achieving in technology. When supported by teachers who are well-versed in the technology curriculum, and knowledgeable of the age-group, I have found that the resulting developments can be quite impressive.

Another opportunity was presented whilst I was a research assistant at CSTER (the Centre for Science and Technology Education Research) to investigate the effectiveness of programmes for curriculum-based learning experiences outside the classroom. Details of my involvement in this contract are described in Section

1.4, however, at the completion of this research, I became aware of a lack of cohesion between the teachers' curriculum knowledge and their understanding of EOTC as a teaching genre. Whilst excursions away from the classroom may be exceptionally well organised, with high quality presentations at the MoE funded sites, the connection between these and the classroom programmes were at times tenuous and without clearly defined learning intentions.

A change of role at the university to that of a full-time lecturer hastened my commitment to enrol in a PhD, and whilst my interest still lay with the junior primary students, the combination of learning experiences outside the classroom and technology education provided an interesting context within which to position my study.

1.3 Rationale

The direction, the journey, and the accompanying story of this study emerged from two distinct beginning points. One was a personal interest in the topic of EOTC created by my involvement in the previously mentioned Ministry of Education (MoE) project. The other was more personal – the story of a small boy's first school trip to a museum which, from his perspective, proved to be an unhappy and futile experience.

The MoE project involved a review of national and international literature on LEOTC (Learning experiences outside the classroom), gathering data from the six schools selected to participate in the project, and developing a case study which described each class's visit to a designated Ministry of Education site. The project concluded with a synthesis of all sets of data compiled in a report to the Ministry of Education (Moreland et al., 2005). My role in this project included the initial literature search and the development of four of the six case studies. Each class visit was part of a more extensive unit of work, for example the visit to the Rotorua Museum followed up and concluded an extensive study of volcanic activity in the area; the excursion from Auckland down to the Marine Research Centre in Dunedin explored marine life and the food chain entitled "Who eats who"; the experience at the Art Museum in Wellington concluded a whole-school focus on The Arts and Education Outside the Classroom; and the visit to the

Waitomo Caves was part of a study entitled ‘Me and my environment’ and had a focus on preservation and conservation (Moreland et al., 2005).

Although the practices of the teachers and Education Officers from each site provided excellent learning opportunities for the students, the research did not fully establish the learning intentions of each visit and was consequently unable to evaluate the extent of the learning achieved. In addition the examples contained within the literature, and the case studies of the contract, focussed on teaching and learning in The Arts, Science and Social Studies, and I recognised an opportunity to delve into this further and explore the same learning opportunities in Technology Education. A key element of Technology Education is ensuring students are well informed and critical of the products they design. The most beneficial way of achieving this is by engaging on-site with experts in the field, and observing the technological practice of an industry.

A final driver which emerged as a result of the MoE contract case studies was the age of the participating students. These ranged from six-year-old students through to twelve-year-old students, and again there appeared to be little information about the needs of the youngest school aged students – the five year olds.

1.4 Research focus and research questions

The title of this study is *The EOTC milieu as a setting for teaching and learning experiences for five-year-old students in Technology Education*. To address the goals of this investigation, the following question was posed:

How is the learning of five-year-old students in technology education enhanced through relevant experiences outside the classroom?

This question was explored through the following sub-questions:

1. How can a technology unit for five-year-old students, which incorporates an experience outside the classroom, be planned for?
2. How does a site visit contribute to the learning intentions of a technology unit for five-year-old students, which incorporates an experience outside the classroom?

3. What are the learning outcomes of a technology unit for five-year-olds that incorporate an experience outside the classroom?
4. What enduring understandings do five-year-old students retain from a technology unit, which incorporates an experience outside the classroom?

This was to be an investigation into how best to structure the learning experiences of young children outside the classroom, and, as a context for the study, how this relates to teaching and learning in Technology Education. By observing and analysing student behaviour and learning in the environments both in and outside the classroom, I hoped to highlight aspects of teacher planning that could impact on the effectiveness of young students learning in Technology Education. What and how young children learn in environments other than their usual classroom, and the degree to which novel experiences can detract from or enhance the learning in the classroom, may have implications for many educators working in this field.

1.5 Research design

The following chapters describe a qualitative study positioned within an interpretivist paradigm. The study employed a case-study approach, in which two classes of five-year-old students participated in a technology unit and a visit to a chocolate factory. The collection of data comprised three phases: preparing for the visit to the chocolate factory; visiting the factory and an interview following up the visit one month later; and a second interview six months later. Triangulation of data was achieved through a series of interviews, observations and document analysis. These provided extensive information upon which to explore answers to the research questions listed in Section 1.4.

Phase One of the study established the students existing knowledge of chocolate and chocolate-making, their perceptions of technological practice, and the context specific language that was already a part of their every-day conversations. Phase Two provided a picture of the understandings the students developed as a result of their visit to Candyland, their ability to transfer these to new and different contexts, and the development of further context-specific language. It also indicated the impact their experiences at the factory had on their own technological practice and the design and construction of their chocolate gift for

Mothers' day. Phase Three occurred six months after the completion of the teaching unit and consisted of an interview with each of the students. The key focus of this interview was to understand which elements of the visit and the technology unit had been retained by the students and to consider which aspects of their experience supported this retention.

1.6 Significance of the project

The Ministry of Education in New Zealand supports schools providing opportunities for their students to participate in learning experiences outside the classroom. During the last decade, the Ministry has purchased services for the benefit of students enrolled in New Zealand's state, integrated and registered private schools from which they can experience focussed, classroom-related learning experiences outside the classroom (LEOTC) (Ministry of Education, 2010a). These services are available throughout New Zealand and include sites such as museums, historic parks, zoos, art galleries, and science centres.

Whilst exploring the literature pertaining to student learning in EOTC sites, it became apparent that most research centred on science and science-related sites, with the majority undertaken in museums. Very little literature concerning other learning areas and sites was located. The work of Falk and Dierking (1992) appear to dominate this field of study providing much of the foundational field work and research in museums upon which many recent studies have been based.

A further consideration is the origin of most literature relating to EOTC. This generally stems from research carried out in the United Kingdom, Australia and the USA with little that can be traced back to New Zealand. The work of MacKintosh (1998), Bolstad (2003), Tofield, Coll, Vyle and Bolstad (2003) and more recently, Moreland, McGee, Jones, Milne, Donaghy and Miller (2005) are the exception. It would be valuable to extend this further and offer teaching and learning guidance to teachers who incorporate EOTC into their teaching programmes and which is specific to junior primary students and to the New Zealand environment. Teachers are more likely to engage with contexts which they can relate to and which they see as relevant to their students (Bolt, 2009).

Technology Education, as the key focus in this study, lends itself naturally to EOTC. The New Zealand curriculum advocates connections with outside agencies and providing students with examples of expert practice. There is no published evidence of this, that I am aware of, which relates specifically to the learning experiences of very young school-aged students. Studies have been conducted which focus on older primary-aged students, and there are a number of publications which relate to secondary school students learning outside the classroom. I believe that the learning needs of the five-year-old student is also worthy of further investigation.

Technology education is a compulsory requirement for all New Zealand students, including the New Entrant student. The learning needs of these students are quite specific – what interests them, what they notice and what they ignore, their prior knowledge and the effect of their language development, may all impact on their learning and their capacity to fully engage in the opportunities provided.

It is anticipated that the recommendations which result from this research may go some way to further educators' understandings of merging EOTC with Technology Education at both a national level, including the curriculum planners and developers, pre-service educators, and also at the classroom level of primary and early childhood teachers.

1.7 Outline of the thesis

This thesis is organised into the seven further chapters outlined below.

Chapter 2 Literature review: This is a description of the topic and a summary of the literature pertinent to the research questions. There are three key areas of interest, Technology Education, EOTC and the characteristics of five-year-old learners. Technology Education is organised according to the LITE Project (Jones, Moreland, & Chambers, 2000) themes of analysis – students' conceptual knowledge, procedural knowledge, technical knowledge and societal knowledge. EOTC is examined using the Contextual Model of Learning framework that consists of three over-lapping contexts, the personal, the socio-cultural and the physical elements of an experience away from the classroom (Falk & Dierking, 2000). The themes which structure discussions concerning the characteristics of five-year-old learners include students' level of interest in the context, their transfer of ideas and their language development and language competency.

Chapter 3 Methodology and research design: This chapter describes the theoretical framework of the research, the methods, processes, and analysis that guides the research. The justification for their selection is included.

Chapter 4 Framework development and intervention: this describes a planning model for a learning experience outside the classroom for five-year-old students in technology education. The model was trialled using a case study approach in which the students participated in a visit to a confectionery and chocolate-making factory, known as Candyland, in order to examine the practice of experts before designing and making their own chocolate gift for Mothers' day.

Chapter 5 Findings 1: Preparation for the visit: The research comprised two case studies. Planning for each case study was divided into three phases of intervention, broadly described as (i) preparation for the visit, (ii) organisation during, and development after the visit and (iii) enduring understandings of the visit and subsequent classroom work. This chapter examined (i) preparation for the visit.

Chapter 6 Findings 2: This chapter examined (ii) organisation during, and development after the visit.

Chapter 7 Findings 3: This chapter examined (iii) enduring understandings of the visit and subsequent classroom work.

Chapter 8 Discussion and conclusions: This chapter discusses the findings of Chapters 5, 6 and 7 in light of the research questions and the literature review of this study. Conclusions and implications for teaching five-year-old students when integrating technology with experiences outside the classroom are also considered. A proposal for future research completes this chapter.

Chapter 2
Literature Review

2.1 Introduction

Technology Education has been a compulsory subject in the New Zealand curriculum since 1999 when the traditional subjects of cooking, sewing, metalwork and woodwork were formally revoked. Expert practice in this curriculum and the reviewed curriculum of 2007 are fundamental to the development of students' technological literacy and whilst this may be acquired within the classroom, this study argues for and investigates the viewpoint that this may be achieved most effectively in concert with learning experiences outside the classroom.

Anderson and Arsenault write that "a literature review is designed to summarise, analyse, and interpret, the conceptual and theoretical research related to a research project" (1998, p. 76). They remind us that reviewing literature is not something that is "done, completed, put aside and forgotten" (p. 76). This resonates well with this study because the review of literature as a background to this study has been an on-going and continuous process, aimed at reflecting current publications and the changes that have occurred in my own thinking. The intention of this literature review is to investigate publications that preceded this study, some of which, although published over 30 years ago, explore concepts that are relevant and that have undergone little reconceptualisation since then. Knowledge of these earlier publications establishes the pathway of prior research and thinking upon which to position my study (Mutch, 2005). This early thinking was developed further through more recent publications and, of particular relevance to this study, are those that relate to the New Zealand technology curriculum, which has undergone significant change since the publication of the revised 2007 New Zealand Curriculum (Ministry of Education, 2007b).

The investigation of five-year-old students' (referred to as New Entrant students in the New Zealand schooling system), learning outside the classroom in technology education has necessitated a broad sweep of several key areas of research with some elements being developed further in Chapter 4, The Intervention Model. Accordingly, Chapter 2 is divided into the examination of three key areas of literature: education outside the classroom (EOTC), technology and technology education, including the expectations for New Entrant students participating in this curriculum, and the characteristics of five-year-old students' learning experiences. Each of these sections has been organised into several subsections as indicated in Table 2.1 below. The assimilation of these investigations begins to provide some background to the research questions listed in Chapter 1.

Table 2.1 Chapter 2 overview

Education outside the classroom	**Technology and Technology Education**	**Characteristics of 5-year-old learning experiences**
2.2.1 Introduction 2.2.2 The nature of schooling 2.2.3 Defining EOTC 2.2.4 Learning in EOTC 2.2.5 The impact of learning experiences outside the classroom on student learning i) Long-term achievement and retention of learning ii) Contextualised education beyond the classroom improves student learning outcomes iii) Characteristics of EOTC programmes, which help ensure positive gains in student learning outcomes 2.2.6 Section summary	2.3.1 Introduction 2.3.2 The origins of technology 2.3.3 An overview of the philosophy of technology i) Technology as artefacts ii)Technology as knowledge iii) Technology as activity iii) Technology as a characteristic of humanity 2.3.4 Technology Education in the New Zealand curriculum 2.3.5 Expectations for New Entrant students participating in Technology Education 2.3.6 Section summary	2.4.1 Introduction 2.4.2 The influence of Piaget in education research 2.4.3 The influence of Vygotsky in educational research 2.4.4 The information processing theories i) Sensory memory ii) Working memory iii) Long-term memory 2.4.5 Funds of Knowledge 2.4.6 Section summary 2.4.7 Chapter summary

2.2 Education Outside the Classroom (EOTC) as a strategy to enhance student learning

2.2.1 Introduction

The literature of Education Outside the Classroom (EOTC) is mostly limited to two fields of interest. The majority of the research carried out so far centres on science and science-related sites, with most studies situated in museums. With the exception of Health and Physical Education, which has a substantial research literature of its own, very few publications have investigated student learning outside the classroom in other curriculum areas such as Social Studies, The Arts, or Technology Education. The science-based publications, which have grown in frequency in recent years, invariably link to the work of leading researchers such as Falk and Dierking, (1992, 2000) whose main area of interest was in science education and students' learning in museums. No evidence has been found of research carried out with very young school-aged students. This study, whilst building on the research of Falk, Dierking, and other researchers working within this area of inquiry, is unique in its focus on five-year-old students, travelling outside the classroom to a factory site where they gather information to inform their own technological practice of making chocolates for Mothers' Day.

To begin, section 2.2.2 takes a brief look at the nature of schooling, the origins of the education system in New Zealand and the development of programmes that acknowledged the value of students working outside the four walls of the classroom.

2.2.2 The nature of schooling and how it relates to learning outside the classroom

Within a school culture there is an assumption that education outside the classroom is inherently good and impacts positively on student learning. As part of my quest to examine student outcomes of this type of experience, the origins of schooling were investigated in order to establish the historical foundations upon which today's educational practices and beliefs are built. I studied examples of indigenous and tribal education, (Cajete, 1994; Mead, 2003) the early education of Greek and Roman youth (Brickman, 1985), the Church-controlled schooling of the Middle Ages (Jarman, 1970) through to the education of young children in New Zealand provided by missionaries in the early 1800s (May, 1997).

The driving force behind all education, now and during those early times, was needs-based – to meet the needs of the family, the needs of the community and the needs of the state. A brief glimpse of ancient tribal education is seen in the work of Cajete (2004) and Mead (2003), in which the education of young men and women is presented as an integral part of their lives, during which they learned through participating in and observing every day activities within their tribe. Storytelling, rituals and ceremonies, artistic creations and learning through apprenticeship in specific tribal tasks, e.g. weapon-making or pottery-making, were all facets of the on-going education of the tribal youngsters (Cajete, 2004). The living environment, the cultural beliefs of the tribe and the daily requirements of the people themselves were naturally intertwined, and these in turn drove the "knowledge, perception, experience, and wisdom afforded through the understanding and experience of tribal elders" (Cajete, 2004, p. 33). This informal mode of learning contrasts sharply with the practice of many tribes in order to transfer 'sacred knowledge', for example, within the Māori tribes of New Zealand. Mead (2003) describes a rigorous and graded progression with a tutor or tohunga (a Māori priest or performer of sacred rites), in which groups of students worked together in order to learn sacred tribal customs and ceremonial practices. This practice relied heavily on students' ability to memorise songs and chants and, in the case of Māori youngsters, to retain and then recite the information passed onto them (Mead, 2003). Within Māori tribes and other indigenous groups, for example, the Native American Indian, where there was no written word and limited methods of recording detailed accounts of tribal life, the overriding goal of these practices was to ensure tribal customs could be sustained through the centuries (Cajete, 2004). As a whole, Cajete maintains that tribal education is best denoted as experiential learning, "learning by doing and seeing, by listening and imagining", and" learning through apprenticeship" (p. 34). It is this bringing together of groups of youngsters for a common goal that links most closely to what we recognise today as an established system of education.

From early pre-Christian times, and over the next few centuries, learning, the study of thought and of the arts thrived, and regions such as Greece, Rome, the Mediterranean and eventually a large part of Europe, began to absorb new ideas and incorporate them into their own culture and way of life. Early travel between nations, often as a result of conflict and/or conquest, led to systems for recording language and, as described by Brickman (1985), an ever-increasing exchange of knowledge in the fields of literature, philosophy, mathematics and the sciences among the peoples of Europe, Africa, and Asia.

In these very early times in Western Europe, prior to the fourth century BC, a period when unrelenting phases of war occupied the main focus of the Greek states, young men of the ruling classes were schooled together in the art of war, preparing them for a career in the military (Jarman, 1970). The children of farmers and labourers were schooled by their fathers, their employers or their elder brothers to work the land and provide food for the nation. Crafts vital to the everyday functioning of towns and cities, such as building, carpentry or ironwork, were learned either in the family of the craftsman, or by apprenticeship to a master artisan.

In later centuries, the influences of the early philosophers such as Aristotle and Plato brought about changes that favoured sons of the affluent classes with a more balanced education, in which both the physical and intellectual natures of their being were developed in order to better prepare them for adulthood (Jarman, 1970). During this period, groups of students were gathered together in covered galleries or verandas and taught to read, write and calculate under the guidance of a tutor. The effectiveness and expertise with which these ‘schools’ functioned, obviously changed over time, were influenced by other nations, and spread through the various strata of society over the centuries. However, there are repeating themes, which become apparent as we continue to explore education. Firstly there is the quest for qualified or expert teaching, and secondly, depending on the nature of the teaching, the notion of bringing together groups of children or adolescents in order to teach them skills and knowledge, which would benefit the society in which they lived.

A key focus for this study is the education of five year olds, and historically these students were catered for by educators whose interest was early childhood education rather than schooling as such – the term schooling usually referring to children over the age of six or seven years (May, 2013). The interest in this group of children, excluding those from affluent families, was motivated initially by social control rather than education. Groups of young children who roamed the streets while their mothers were at work were seen as a serious social problem in the early 1800s in Europe (Silver & Silver, 1974) and the trend continued in the newly colonised regions of New Zealand. Educational reformers of the time felt that the most effective way of preventing this was to gather these groups of children together, place them into infant schools and “socialise them through discipline, moral training and instruction as a preparation for schooling and work” (May, 1997, p. 15). Infant mortality rates were high during this period and concern for the survival of young children as well as their education was reflected in an increased political interest in early childhood care (May, 2013). Various champions of the cause emerged over the next century, including educators such as Frederick Oberlin, Robert Owen, James Buchanan and latterly Samuel Wilderspin.

Each of these pioneers in education had his own perception of early childhood schooling and the reasons for implementing it. However, it is the work of Wilderspin that is acknowledged today as providing the blueprint for the infant school movement throughout Britain and her colonies (May, 2013).

Wilderspin's philosophy, based on the earlier work of Owen and Buchanan, advocated developing not only a child's intellect, but also developing his/her feelings, a spirit of enquiry, opportunities for group activities and play, and, of particular relevance in this study, learning through experience, through the arts and through nature. This was manifested in his invention and fierce promotion of the school playground, which he describes in his publication entitled, *Developing the Intellectual and Moral Powers of all Children from One to Seven Years of Age (Wilderspin, 1852).*

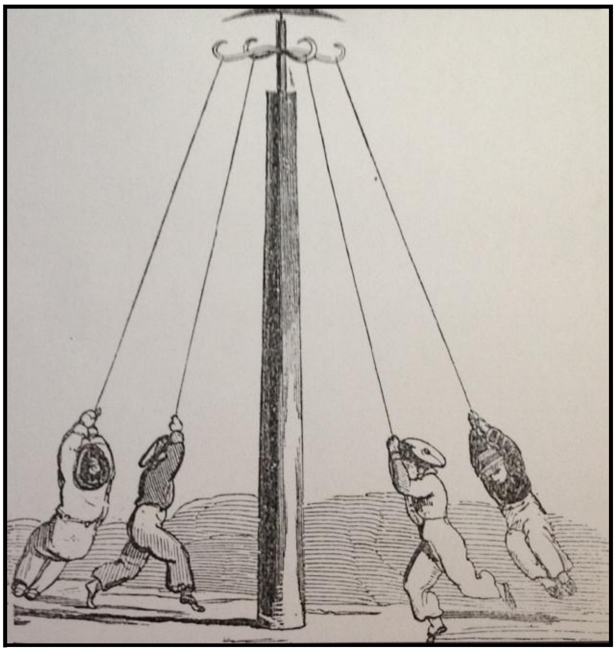


Figure 2.1 Samuel Wilderspin's rotating swing design for infant playgrounds

When describing his vision of an outdoor environment that included a rotating swing (see Figure 2.1), blocks, a garden and fruit trees, he stated: "They will besides, afford the teacher an opportunity of giving the children many useful lessons; for the more he teaches by things, and the less he teaches by signs, the better" (Wilderspin, 1852, p. 103).

Waves of Wilderspin's philosophies along with those of his contemporaries reached the shores of Victorian New Zealand with the arrival of the early missionaries and their wives in the 1830s, and latterly an immigrant population whose lives were dominated by religion (Arnold, 1973 cited in May, 2013) and the culture and values of their 'mother country'. During this period, a number of 'infant schools' were established throughout the country – schools that catered for Māori and settlers' children from two to seven years, and largely for those 'underprivileged' whose parents could not afford to educate their children privately. At this time, the concept of the 'Infant School' and the compulsory nature of education for children from five to 15 years brought about the natural separation of what we would now regard as pre-school children and school-aged children. The Infant School catering for children no younger than five years was generally merged with existing primary schools, though at times functioning independently and often influenced by Froebel's 'kindergarten system' in which activity, play and the environment provided the basis for learning.

Froebel (1782 – 1852) was a German educationalist who coined the phrase 'kindergarten' – a concept that arose from his vision of a child's garden and which became a metaphor for the relationship Froebel envisaged between the child and the world (May, 2013). He is best known for his recognition that children have unique needs and capabilities and should be nurtured and protected from the outside world. As in Wilderspin's work, we see a philosophy that recognised that children's engagement with the natural environment was healthy and provided many opportunities for authentic learning, and that was most effectively approached through the interest and needs of the child.

The National Library archive provides a site referred to as the *AtoJs* that contains reports to the government at the time from the Minister of Education and the Chief Inspector of Schools (National Library of New Zealand, 2010). A report presented in 1895 offered a particularly forward-thinking illustration of the official attitudes towards educating primary-aged students at this time and is of relevance to this study. Mr G.W. Kekewich, an inspector of schools, referred to the value of 'object-teaching', (National Library of New Zealand, 2010) which aligned well with the philosophies of both Wilderspin and Froebel. He describes object-teaching as a method in which "the scholar acquires knowledge by observation and experiment" and in a manner that requires him to use his senses (p. 13). He goes further to suggest that lessons about elephants, for example, which are delivered through the use of pictures and drawings, although imparting useful information, will be secondary to visiting a zoo and observing the creature for themselves. Furthermore, it is stated that "visits to museums and other institutions of educational value are now recognised by the Code, and may advantageously be undertaken where possible in connection with the object-teaching". (Reference to the Code is not clear but I suspect this equates to current policy at the time).

The extensive resource provided by the National Library archive, and referenced above, reveals the early threads of current philosophies and practices supporting the education of students outside the classroom.

The ensuing period marked by the First World War, the depression of the 1920s and the Second World War impacted severely on the funding available for resourcing schools and, despite an unrelenting philosophy of free education for all, cut-backs were made at all levels of the education system; teachers' salaries were reduced, the school entry age was raised, and many grants and services were stopped or reduced. However, the previous political and educational interest in young children's health and survival, and later their moral development, moved on to a concern for their physical well-being. The period of the war years heralded many developments in medicine, the physical sciences and the emerging fields of sociology and psychology, which together provided "new tools and rationales for the management of the early childhood years" (May, 2013, p. 21). May noted that during the period of the 1930's and 1940's, the practices carried out within kindergartens (and schools) began to respond to new government-initiated campaigns for the health and welfare of children and the emergence of psychoanalytic pedagogy to inform teaching (p. 21). The impact of this research was very limited and had little effect on improving teaching practices. McGee and Penlington (2000) reported that, "although researchers attempted to identify effective teaching methods, the teaching process as it occurred in classrooms was largely ignored" (p. 5). Despite this, the early publications of the 1930s continued to reflect the on-going concern for the health and well-being of school-aged students. The syllabus for Physical Training published in 1933 states:

> Physical Education includes all activities likely to minister to physical health, not only gymnastics, games, swimming and dancing, but sports, free play, walking tours, school journeys, camps, and all forms of occupation and exercise likely to create a love of open air and a healthy way of living (Board of Education, 1933, p. 9).

Again we see an early reference to the use of the outdoors and environments away from the classroom, which were seen to be both enjoyable and of benefit to school-aged students. The educational advantages of these activities are not documented here. However, the Nature Study syllabus of a slightly earlier era refers to “practical outdoor work”, which included recording drawings of “natural objects” and the development of school gardens for teachers and students to maintain (Education Department, 1907, p. 6).

Prior to the comprehensive revision of the whole school curriculum in the 1990s, the curriculum was specified through more than a dozen syllabuses and guidelines (Ministry of Education, 2007a).

These were provided for all taught subjects, and in some cases, aspects of subjects, such as handwriting. The documents were of different vintages spanning 1961–1986, covered different year levels, and were written in different forms. However, aside from some changes in emphasis as a result of technological developments in the later twentieth century, and an increased leeway for schools to tailor the curriculum to their own needs, little changed over this period until the Lange-led Labour Government of 1984-90. During this Labour Government period, radical reforms took place. Referred to as ‘Tomorrow’s Schools’ and based on a report by Brian Picot (Picot, Ramsay, & Rosemergy, 1988), school administration underwent huge changes. A key element of this enabled parents, teachers and the wider school community to have far greater influence over the decision-making and directions their schools were to take.

The 1990’s saw the publication of new curricula by the Ministry of Education, including a particularly significant new publication of the first early childhood curriculum. This is referred to as *Te Whaariki*, meaning the mat that weaves together the principles, strands and goals of the document (Ministry of Education, 1996). In an examination of the key elements of this curriculum, it is apparent that significant changes have taken place since the arrival of the early settlers, although the on-going concern for children's health and well-being is consistent with pre-school care as far back as the early 1900s. The aspirations for pre-school children today, and upon which the *Te Whaariki* curriculum is founded, are "To grow up as competent and confident learners and communicators, healthy in mind, body and spirit, secure in their sense of belonging and in the knowledge that they make a valued contribution to society" (Ministry of Education, 1996, p.9). These aims are further defined in five strands, which help create a guiding framework for early childhood teachers. These include notions of well-being, belonging, contribution, communication and exploration (Ministry of Education, 1996). The goals that describe each of these strands signal some clear links to this study and the focus on education outside the classroom. There are several references to students exploring the environment and making sense of their social, natural and physical world, particularly in the strand entitled 'Belonging'. In this strand, reference is made to children developing a familiarity with the wider world, developing knowledge about the features of the area, discovering an unfamiliar wider world, and developing knowledge about the wider world of work. In the supplementary text, teachers are asked to reflect on the kinds of opportunities for children "to go on outings or be part of cultural events" (Ministry of Education, 1996, p. 56). They are also asked to consider other available outings or events that may be appropriate for the children. These examples, along with the goals contained within the other four strands of the *Te Whaariki* curriculum, describe an education for early childhood students that reaches far beyond the previous conception of social control.

Working in conjunction with *Te Whaariki* is both the *New Zealand Curriculum Framework* (Ministry of Education, 1993) and more recently the *New Zealand Curriculum* (Ministry of Education, 2007a) and [1] *Te Marautanga o Aotearoa* (Ministry of Education, 2007c), which describe the vision and goals for educating school-aged students. The *New Zealand Curriculum* (2007a) is founded on a vision of setting a direction for young people to be "lifelong learners who are confident, creative, connected and actively involved" (p. 4). The goal for students

[1] Te Marautanga o Aotearoa is a curriculum for Māori-medium schools describing the essential knowledge, skills, values and attitudes for inclusion in individual school programmes.

is to develop the competencies they need for study, work, and to go on to realise their individual potential (MoE, 2007a).

In addition, as outlined on the Te Kete Ipurangi (TKI) website, (a MoE initiative that supports teacher practice), the two curriculum documents encourage schools to develop learning programmes that “reflect the learning needs of their students, build on their previous experiences and have meaning for their students because the learning relates to their lives” (http://eotc.tki.org.nz/EOTC-home/For-teachers). In order to complement and enrich their learning experiences, the Ministry of Education values opportunities for students to experience learning opportunities outside the classroom (http://www.minedu.govt.nz/). Education outside the classroom is not viewed as an alternative to conventional schooling but an adjunct to it. The Ministry of Education website states, that “learning outside the classroom is an important complement to the learning that happens inside the classroom. It brings learning to life” (Ministry of Education, 2010a).

This section has illustrated the changing nature of schooling from the earliest of times and how the position of education outside the classroom has evolved. It reflects the shifting social structures of our communities and the amended understandings of the educational needs of the child. The following section aims to define educating students outside the classroom, by providing an example of a curriculum-based teaching and learning approach.

2.2.3 **Defining *Education Outside the Classroom (EOTC)***

Education Outside the Classroom (EOTC) in New Zealand is a generic term used to describe the curriculum-based learning and teaching in schools that occurs outside the classroom. Internationally similar terms are used, for example in the UK, the term Learning Outside the Classroom (LOTC) is used and is guided by a similar philosophy to that of New Zealand. EOTC may encompass many different types of experience, ranging from a field trip to a bird sanctuary such as Zealandia in Wellington (Karori Sanctuary Trust, n.d.), the Rotorua Museum of Art and History (http://www.rotoruamuseum.co.nz/), or the Waitomo Glow-worm caves http://www.waitomo.com/. It may also include visits to organisations such as Dance Aotearoa New Zealand (Dance Aotearoa New Zealand, n.d.), or site visits to local industries or factories such as Candyland (Candyland, n.d.), the confectionery factory outside Hamilton and the site chosen for this study.

In this study, EOTC is defined as any learning experience that extends beyond the four walls of the school classroom. Programmes may include outdoor education, adventure education or other curriculum-based programmes, which are intended to complement students' in-school learning and to provide experiences that could not be made available inside the classroom. A key aspect of each of these experiences is that they provide links between their classroom studies and their real-world experiences. Activities are expected to be hands-on, interactive, and to enrich the learning opportunities provided by the New Zealand curriculum (Ministry of Education, 2010a). The Ministry of Education website (http://www.minedu.govt.nz/), which describes the key elements of EOTC for teachers, states that experiential education methods are generally used in the delivery of these types of programme. Excursions that are substantively for the purpose of recreation or entertainment are usually precluded from the EOTC category.

In a policy review paper for the Ministry of Education, Deaker (2006) confirmed that organising excursions outside the classroom had been a common practice in New Zealand schools for many generations (Alton-Lee & Nuthall, 1990). However, the value of such experiences and the advantages offered to students was only formally acknowledged as a result of the 1989 'Tomorrow's Schools' reforms. At this time, a Ministry of Education staffing fund was made available to a number of providers, e.g. science centres, zoos, art galleries and museums, to assist in the provision of qualified staff to work with groups of visiting school students (Deaker, 2006). This fund was referred to as the LEOTC (Learning Experiences Outside the Classroom) contestable contract system, and although over time this has under-gone several administrative and operational changes, the scheme continues strongly today (http://eotc.tki.org.nz/LEOTC-home). The LEOTC project specifications, which were developed and refined over time, were built on three fundamental requirements – providers should demonstrate support for the New Zealand curriculum, they should understand the principles of learning and teaching, and they should offer appropriate facilities, systems, experiences and expertise (Deaker, 2006). By 2006, the requirements for gaining access to funding were more prescriptive and providers were expected to be "curriculum focussed, to work closely with teachers and to provide authentic, hands-on, interactive and specific learning experience" (p. 5). They were also to "complement the learning going on back in schools' classrooms" (p. 5). Through the provision of these services, the New Zealand Ministry of Education has clearly demonstrated its support for education outside the classroom and during the last decade has purchased LEOTC services for the benefit of students enrolled in not only New Zealand's state schools but also all integrated and registered private schools. There are currently 63 of these funded LEOTC sites scattered throughout every region in New Zealand.

The Ministry of Education's commitment to education outside the classroom was further endorsed by the publication in 2012 of the *EOTC Guidelines – Bringing the Curriculum Alive*. This is a comprehensive document based on the premise that in order to extend students' learning experiences outside the classroom "schools need to take advantage of the opportunities offered by the wider community and the environment" (Ministry of Education, 2012, p. 3). The Guidelines quote the work of Alton-Lee and Nuthall (1990) in which it is argued that by students making links between their classroom studies and real-world experiences, their long-term learning is advantaged (MoE, 2012). Effective teaching strategies and well-designed curriculum-based experiences are key elements of EOTC as is the opportunity for students to participate and learn in a safe and risk-managed environment.

2.2.4 Learning in EOTC

Falk and Dierking (2000), whose main area of interest was in science education and students' learning in a museum, describe the student learning experience outside the classroom as "a whole-body, whole-brain activity, whole-experience," (p. 10). To this end, and over time, they developed what is known as the Contextual Model of Learning. This consists of three over-lapping contexts, the personal, the socio-cultural and the physical (Falk & Dierking, 2000). The personal context includes motivation and expectations, prior knowledge, interests and beliefs, and choice and control. The socio-cultural context includes within-group socio-cultural mediation and facilitated mediation by others. The physical context includes advance organisers and orientation, design and reinforcing events and experiences outside the museum (Falk, 2004). At a later stage the fourth dimension of ‘time’ was added, as further research indicated that random events could occur during a visit, which interrupted the experience and were likely to impact on the quality and quantity of visitor learning. For example, a child needing to be taken to the bathroom whilst family members were reading information about the layout of the museum could mean that the family then missed important information, and possibly directions, which might cause them to overlook worthwhile exhibits.

Falk and Dierking (2000) argue that learning can best be thought of in terms of “the personal context moving through time; as it travels, it is constantly shaped and reshaped as it experiences events with the physical context, all of which are mediated by and through the sociocultural context” (p.10). The Contextual Model offers a comprehensive framework within which to plan a learning experience outside the classroom. This study draws on all of the four key features of this framework, as well as other factors that relate specifically to the learning of five-year-old students outside the classroom (see Section 2.4).

The type of learning most commonly associated with learning outside the classroom is informal learning. This is a generic term, which is often associated with models of ‘flexible learning’, or ‘free-choice learning’ (Dierking & Griffin, 2001; Rennie & McClafferty, 1996; Tofield, Coll, Vyle, & Bolstad, 2003). Greenfield and Lave (1982) describe informal learning as that which is embedded in daily life activities, where the learner is responsible for obtaining knowledge and skill, and is motivated by the social contribution of novices and their participation in the adult sphere. Ash and Klein (2000) list features of informal learning as being fun, visually oriented, co-operative, interactive, short-term, open-ended and non-structured. They report on the work of Ellenbogen (1998) which contends that educators have often compared informal learning with their understandings of formal learning in order to further clarify the term. The pedagogy of the classroom teacher today, however, is far removed from the traditional, didactic approach of classroom instruction from the past, and as a result, there is a level of ambiguity that seeps into this perspective. Students today are encouraged to be “active and visible members of the learning community of the classroom … in which learning conversations and learning partnerships are encouraged and challenge, support and feedback are always available" (Ministry of Education, 2007a, p. 34). This bears little resemblance to some of the traditional practices of formal education.

Historically, informal learning also refers to that which occurs outside of school, however, here again an unhelpful distinction has arisen (Falk, 2001). By categorising the type of learning purely by the physical setting of a school or a museum, for example, it is suggested that learning is impervious to all other factors. Falk (2001) argues, "It is clearly absurd to suggest that seating children in a museum auditorium and requiring them to hear a lecture is somehow different from seating children in a school auditorium to hear a lecture" (p. 7). On the other hand, "open-ended, optional, inquiry-based experiences within a school setting" show no fundamental difference to those carried out within a museum setting (Falk, 2001). In response to this view, the term "free choice" learning is favoured by Falk and Dierking (2000) to best describe the learning that occurs outside the classroom. The characteristics of free-choice learning include non-sequential, self-paced and voluntary participation. In addition, free-choice learning not only recognises the impact of the physical environment on student learning but also the sociocultural nature of learning. By understanding the interplay that occurs between these and the visitor, Falk and Dierking argue that a more accurate description of learning outside the classroom is attained (Falk, 2001). Similarly, Tofield et al. (2003) argue that student learning should not be based on what is intended by the exhibit designer, but rather what the student makes of the exhibit. These views are not without their critics. However, Falk and Dierking's concept of "perceived choice" (p. 8), instead of free-choice, resonates well with the visit that was enacted as part of this study. Whilst a set of predetermined learning intentions from the New Zealand curriculum were selected by the teachers and researcher, the participants were motivated by a "need to know" factor, i.e. how to make a chocolate gift for their mother, as well as the motivation offered by the students' very predictable interest in the chocolate-making context. It was anticipated that learners might approach such a visit with a sense of freedom to select or take note of items that appealed to them and processes they thought would have relevance to their task of making a chocolate gift. In effect they decided when, where and what to learn.

There is an additional category of education, which emerged in the late 1960's and early 1970's, and is referred to as non-formal education. This is another term that acknowledges the value of learning that takes place outside established educational institutions but tends to be organised by community groups, and often with the purpose of advantaging groups of children and adults whose access to formal education is in some way obstructed, for example the poor, the isolated, the rural, the unemployed and so on. In his report on the historical perspectives of non-formal education, Grandstaff (1974), describes it further as tending to arise from immediate community needs, being supported by a range of sponsors and looking to address short-term rather than long-term goals. A more recent publication notes that non-formal education is no longer the domain of third world countries, but is recognised internationally. Rogers (2005) quotes the Parliamentary Assembly of the European Council, which describes non-formal education as that which is semi-structured, consisting of planned and explicit approaches introduced into work organisations and elsewhere, not recognised within the formal education and training system.

It would seem, therefore, that in categorising the type of learning to be experienced by the participants of this study, the notion of 'free-choice learning' and 'perceived choice' offer the most accurate description. These students are being educated within a formal schooling system, and the visit, although away from the classroom, is organised by the classroom teachers and approved by the school administrators. The experience is an adjunct to their learning in technology education and not because they or their families are in any way disadvantaged, or that they are participating in a community-initiated experience.

2.2.5 The impact of learning experiences outside the classroom on student learning

Although, as noted earlier, there is a feeling that education outside the classroom is fundamentally good and impacts positively on student learning, what evidence is there for this view? Three main themes have emerged from the literature review that have relevance to this question; (i) the long-term achievement and retention of student learning, (ii) contextualised learning beyond the classroom and its impact on student learning outcomes; and (iii) the characteristics of EOTC programmes that support positive gains in student learning outcomes. The following section presents some of what is known about each of these themes.

2.2.5.1 Long-term achievement and retention of learning

The literature that relates to learning outside the classroom, as previously pointed out, invariably refers to research that focuses on the informal learning experienced by visitors to museums[2] – children and adults attending a museum of their own free will, often during school holidays or at the weekend when time is available for recreational pursuits. Whilst this, in some ways, conflicts with the nature of this study, with its focus on school children visiting a site outside the classroom as part of a school technology project, there is a significant over-lap particularly around the perception of 'perceived choice' as described in Section 2.2.4 (Falk, 2001).

In my experience as a child growing up in New Zealand and as a primary school teacher for many years, the 'school trip' in New Zealand, whether to a museum, a science centre, the local swimming pool or to a more 'exotic' location outside the local area, evokes strong memories for many New Zealanders. Regardless of how many years have passed since an event occurred, most readers will remember, with some clarity, a day when they boarded a chartered bus and set off through the school gates on a class excursion. The social dimensions of the visit are, in many cases, the most memorable aspects of the experience. Falk and Dierking (1997) confirm that, as students who have participated in these types of excursions, we have excellent recall and can remember where and with whom we went and at least three aspects of what occurred during the visit. As a 15-year-old living in the small East Coast city of Gisborne, my own memory of a class visit to Auckland is very clear 45 years later. The details, as indicated by Falk and Dierking, centre on the social dynamics of the group and the tomfoolery of a group of excited teenage girls away from home for the first time. The science behind the operation of the Auckland sewage disposal centre, the educational reason for the visit, is less well recalled – aside from the appalling smell. As outlined in the early work of Falk and Balling (2001), the most valuable and memorable learning experiences

[2] In the literature associated with learning outside the classroom, the term "museum" can be used as a generic term referring to a broad range of informal learning environment, for example, art galleries, science centres, zoos and historic parks (Griffin & Symington, 1997).

outside the classroom are 'novel' experiences – those that are new, and high-interest. It has been shown that, even in the case of very young children, experiences that fall into the 'novel' category, such as the first visit to the circus or to a fun park, can be recalled some time later with surprising clarity (Hudson, 1983). In his research of the long-term memories of visitors to world expositions, Anderson (2003) argues that "memories were overwhelmingly dominated and mediated by the socio-cultural identity of the individual at the time of the visit" (p. 407). The lens through which the experience is viewed, strongly influences what is noticed and remembered. This refers to the particular interests of an age-group, for example, the pre-schooler, the adolescent male, or the young mother – the interests they had at the time of the visit and what attracted their attention. A pre-schooler may clearly remember the spider in the bathroom during a comfort stop on the way to the circus, but forget the children (s)he travelled with. On the other hand, it is likely that an adolescent male's memories of a visit may include considerable interest in the girls he travelled with and little for the spider in the bathroom (Anderson, 2003)!

The concept of 'novel' activity or experience is explored in the work of Stevenson (1991), in which visitor memories of a museum visit were analysed. In this research the term 'novel' also relates to the frequency of visits to a site. Those visitors who had regularly visited a museum as children were found to have significantly fewer recollections than those who had been infrequent visitors. There may be multiple reasons for this, one of which may be that the type of visit being reported referred to family and recreational visits, rather than one that set out to gather specific information. The selection of a visit to a museum as opposed to a fun park, does, however, suggest some educational intent, and visiting Te Papa[3], for example, to view a short-term exhibition on the origins of the Tainui[4] people, may offer far greater visitor focus than frequent holiday visits wandering through the same long-term exhibitions. In summary, it appears that a one-off, focused visit has the potential to offer students an enhanced and memorable learning opportunity.

[3] Te Papa – translation to English means Our Place: Museum of New Zealand, situated in Wellington, New Zealand.

[4] Tainui is a tribal waka (canoe) confederation of New Zealand North Island Māori iwi or tribe.

A number of researchers argue that, closely aligned with student interest in a visit, is their enjoyment of the visit, with some referring to the effect and value of an emotional connection with the experience, i.e. excitement, wonderment, amusement and even shock (D. Anderson, Thomas, et al., 2003). As part of a Ministry of Education research project carried out in 2002 (Milne, 2002), a class of six-year-old students was taken to the City Gallery in Wellington, New Zealand, to view an art exhibition. The most frequently recalled incident of the visit was their shock as they entered the gallery and had to step over an artificial ‘dog poo’, which had been deliberately positioned in the hallway. The sight of the deposit was met with loud exclamation and protest from the students, before it was explained that it was an intentional joke provided by the artist. The literature review of Anderson et al. (2003) identified many research projects, where the data analysis suggested that enduring and valuable learning outcomes resulted from enjoyable visits to museums. Students’ interests were raised, their attitude towards activities (in this case, science activities) were more positive and learning was enhanced. It would seem, therefore, that whilst students’ memories of a one-off, novel experience are likely to be detailed and retained over time, these memories will be influenced by their age, what is important to them, and the emotional engagement they experienced at the time.

2.2.5.2 Contextualised education beyond the classroom to improve student learning outcomes

Australian researchers Rennie and Johnston developed a particular interest in education outside the classroom and have written extensively around the topic of learning outside the classroom and in museums. They remind us, that within this context, as in other school-based environments, learning is personal, it is contextualised and it takes time. A person’s past experiences, be they cognitive, affective, behavioural, social or cultural, will help structure the new learning in personal ways (Rennie & Johnston, 2004). A visit to a museum will be experienced differently by each member of a touring party, and the value of the visit will be enhanced by how the visitors perceive the purpose of the visit. For example, a group of primary school students viewing examples of technologies from the eighteenth century will have their experience and learning opportunities heightened if they are guided by a desire to obtain specific information. If students visit a site with some prior knowledge of the exhibits and a clear purpose, e.g. to gather information for a teacher-directed task, the combined elements will help give focus to their experience, and their prior knowledge or familiarity with the exhibits will enable them to engage more easily with each display. In contrast, a group touring for recreational purposes may well overlook much of the information available to visitors because of limited interest, lack of prior knowledge and no defined purpose for their enquiry.

Over the last decade, museums, aquaria and other sites have become increasingly interactive in the design of displays that are offered to the public. Learning theorists, including Vygotsky, have recognised the vital role that concrete experiences with real objects play, as a child moves through the various stages of learning (Gredler & Shields, 2008) and, as identified by MacKintosh (1998), the museum is an extensive source of such objects. Yet over the last 20 to 25 years, there has been a world-wide explosion of information resulting in an upsurge of second-hand experiences. For example, when we consider the enormous potential of the internet for accessing information, with websites available on any imaginable topic, and the increasing availability of databases and virtual experiences, students can, with some ease, gather most information they require without moving from the computer console. Hall (1981) argued that direct personal experience was [even then] likely to be missing in the lives of many students. So the changes, which have been observed within many museums, aquaria, and art galleries in recent years, go some way to replacing this scarcity of hands-on, real-world experiences, which previously were an integral part of students gaining new knowledge. Providing students with opportunities to participate in first-hand experiences, through interacting with concrete objects, has the potential to provide an important balance in their learning.

2.2.5.3 Characteristics of EOTC programmes that help ensure positive gains in student learning outcomes

In the last decade, there has been an increase in international research data that aimed to identify the characteristics of programmes designed for students participating in learning experiences outside the classroom. Most of this research, as mentioned previously, focuses on science and learning in museums. However, the analysis of this research brings to light many characteristics of effective programmes, which are easily transferred to a whole range of curriculum-based teaching and learning opportunities outside the classroom. In order to maximise student learning opportunities at sites such as these, a number of key features have emerged. Falk and Balling (2001) refer to settings that should be of appropriate novelty. Sites should provide students with new, interesting and clearly discriminable events or activities, without the distraction of irrelevant stimuli or overly lengthy visits. Not all sites will suit all age groups and so it is important that teachers select sites for students that offer an age-appropriate experience (Wineman, Piper, & Maple, 1996). Falk and Balling (2001) suggest that young children may gain value from very short forays away from the classroom rather than the usual 'day trip' if learning is to be the primary intent of the day. Learning in museums, for example, is dependent on the exhibits, and it is thought that visits to selected exhibitions, rather than making use of the entire site, may offer a more focused experience and subsequently one that is more beneficial for younger students.

A word of caution emerges from the work of Moreland, Jones, Milne, Donaghy and Miller (2005) in which it is argued that limitations placed on students can also have an opposite effect. By constraining the movement of students around a site too strenuously, they may be prevented from viewing displays in which they have a personal interest. This restriction may in itself become distracting and interfere with the previous notion of 'free-choice learning' (Falk, 2001) described in Section 2.2.4. A practical solution is to provide students with a brief period in which to explore the whole site before beginning the more focused phase of information-gathering. Rennie and McClafferty (1996) refer to students needing time to "settle down to work" and being free to "engage in preliminary playing and exploration with exhibits even when they are seriously working" (p.180).

Teacher preparation is another key feature in maximising student learning. Whilst teachers carry out a wide range of out-of-class visits for many different reasons, it appears that where the visit is part of a well-considered and carefully planned unit of work, the benefits for the students are greater. Tofield et al. (2003) in their research at the Hamilton Zoo concluded that "learning was facilitated by pre-planning and appropriate post-visit activities along with the technology-focused presentation by the zoo education officer" (p. 96). Furthermore, they, and others, argue that teachers must link visits to pre- and post-visit activities and to specific curriculum objectives (D. Anderson et al., 2000; Bolstad, 2000; Rennie & McClafferty, 1996). Students should be clear about the purpose for the site visit and, as argued by Anderson (2003), "an individual's motivation and agenda for visiting the site will significantly impact on their learning" (p. 416). Where students are familiar with the learning objectives of the visit, they are able to plan in advance how to best achieve their goals, (D. Anderson et al., 2000; Bolstad, 2000; Rennie & McClafferty, 1996) and they are more likely to be self-directed in achieving them (Rennie & McClafferty, 1996).

In a similar vein, an extensive research project in the United Kingdom of 655 elementary boys and girls who visited a museum exhibit referred to as 'The Challenger Experience' (Jarvis & Pell, 2002), explored the impact student preparation before the visit had on their attitudes towards the science and technology encountered during the visit. It was reported that the students' two- to three-hour experience with the challenger exhibit was a lasting positive experience for nearly a quarter of the children with regard to raising their career aspirations to become scientists. The subsequent challenge was to increase this proportion. A much earlier project carried out by Finson and Enochs (1987) reported similar findings. Where teachers had planned activities to complement their museum visit, students' attitudes towards science, technology and society were significantly increased.

In their research of science centres and science learning, Rennie and McClafferty (1996) identified seven factors that can impact on student learning in a visit to a science centre. As in Falk and Dierking's Contextual Model (2000), these factors consider the personal, social and physical contexts, which influence a student's learning and which have the potential to relate to all types of learning experiences outside the classroom. This multi-faceted view of managing a visit away from the classroom resonates well with taking five-year-old students out of the familiar surroundings of their classroom and into an environment with which they are unacquainted. This type of experience can be very exciting for the students but it can also be unsettling and stressful. Rennie and McClafferty (1996) propose that teachers, who intend taking students on a visit outside the classroom, should give consideration to the following points during their planning:

i) the extent to which students are familiar with the setting

ii) students' prior knowledge

iii) the match between the cognitive level of students and the thought processes required by the exhibits during the visit

iv) the degree of structure of the visit

v) the provision and nature of the cues for learning

vi) the social aspects of the visit (p. 170)

Students' prior knowledge and the role it plays in student learning appears in a range of research literature. Falk and Dierking (1997) contend that "learning is the process of applying prior knowledge and experience to new experiences; this effort is normally played out within a physical context and is mediated in the actions of other individuals" (p. 216). Anderson et al. (2003) and D'Angelo, Touchman and Clark (2009) build on this view and reason that prior knowledge not only influences the learning that occurs, but significantly impacts on the resultant knowledge development occurring after the visit. Falk and Adelman (2003) have also investigated the impact of prior knowledge on student learning and whilst they support the views expressed above, they also identified the importance of visitor interest and made the following observation:

> Regardless of entering knowledge, only visitors possessing moderate to extensive interest showed significant (knowledge) gains. Those with moderate to high interest and limited knowledge were the main beneficiaries (p. 171).

The analysis of their data suggested that there would be added benefits for students if they were organised into groups for a visit, which was based on their interests and the knowledge they brought to the experience (Falk & Adelman, 2003).

A teacher's reason for taking students on a visit can be viewed as *the* most important decision when planning a learning experience outside the classroom. Is it to motivate students, is it to introduce new ideas or is it to consolidate previous learning? Clarity around the answers to these questions will enable the teacher to establish the requirements of the visit and nature of both the venue and the exhibits (Rennie & McClafferty, 1996). Similarly, the students' understanding of why they are going on the visit is equally important and this will impact significantly on their learning outcomes. A finding in the work of Lambert and Balderstone (2000) indicated the importance of teachers creating a 'need to know' factor amongst pupils visiting a museum – effectively arming students with an authentic research purpose for the tasks to be carried out during the visit. A comparison was made in this same study between visits that were related to classroom work and those that were not. The findings indicated that, when a visit was not incorporated into class work, students did less well in follow-up tests than those students who were unable to participate in the visit at all – an interesting result (Lambert & Balderstone, 2000).

An extension of these ideas is that of student perceptions. Tofield et al. (2003) believed that students engaging in a learning experience outside the classroom must be made aware that the environment (in their case, the zoo) is a legitimate learning environment. Analysis of data suggested that these perceptions are likely to affect how students engage with the site and the expectations they have for their own learning. If the site is not recognised as having potential learning possibilities, then it is more likely that many opportunities will be overlooked. Similarly, it is important that both the parents and the students who participate in the excursion to the chocolate factory as part of this study, understand that there is a clear purpose and intent that underpins the visit.

In summary, the intervention planned for the classes participating in this research was built around the characteristics described in this section and these are listed below, beginning with Rennie and McClafferty's (1996) list of seven. The intervention considered:

i) the extent to which students are familiar with the setting

ii) students' prior knowledge

iii) the match between the cognitive level of students and the thought processes required by the exhibits during the visit

iv) the degree of structure of the visit

v) the provision and nature of the cues for learning

vi) the social aspects of the visit (p. 170)

Other considerations from the literature include:

i) teacher and student clarity around the purpose of the visit

ii) selection of a site of appropriate novelty

iii) selection of short focused visits

iv) teacher and student preparation prior to the visit

v) students aquiring a 'need to know' motivation for the visit

vi) inclusion of pre- and post-visit activities linking to the classroom programme

vii) and consideration given to not only the social contexts of the visit but also the personal and physical contexts

This list summarises the key points from literature that relate to education outside the classroom, and which made up the guiding principles of the planned intervention model.

2.2.5.4 The role of parent-helpers during a visit outside the classroom

When teachers plan to take their students on a visit away from the classroom, there are understandably a number of criteria that need attention in order to ensure that students are safe. Including competent adults to help supervise the students is a priority, and an adequate ratio of adults to students during all phases of the visit is another expectation (Ministry of Education, 2011). Schools have the option of deciding on an appropriate ratio independently, based on the age of the students and the type of venue being visited.

The literature of EOTC as discussed in Sections 2.2.4 and 2.2.5 is consistent in the view that students should be well prepared for visits outside the classroom and have the opportunity to engage in activities that follow up on their experience. In this section, a brief summary of recent literature from the field of child development is explored and this offers a valuable insight to how and why this might be achieved.

The role of parent-helpers during a visit outside the classroom is clearly a key ingredient in managing groups of students. The intervention developed as part of this study aimed to create a visit for students that was focused, educationally sound and memorable. It would seem, therefore, that the role of the parent-helpers should incorporate greater emphasis on facilitating learning rather than simply ensuring the students are kept safe and are well-behaved. There is an extensive body of literature in the field of child development that explores conversations between parents and their children, and the impact these conversations have on children's later recall of events. In a longitudinal study of children's memory, Fivush, Reese and Haden (2006) identify these conversations as 'event talk' – naturally occurring talk, which takes place before, during or after an event. Reese and Newcome's (2007) study of children's memory found that there was a link between parents who talk to their children in a richly detailed manner, and the extent of information children are later able to recall of particular events. By training a group of mothers in what they describe as elaborative reminiscing techniques, Reese and Newcome report that "children were able to tell longer, more accurate and richer memory narratives with a researcher" (p. 1168) than those children whose mothers were not trained in using the technique. This training encouraged mothers to use open-ended elaborative questions with their pre-schoolers, particularly questions beginning with *when* and *where*, when talking about the past, for example, "Where did we go this morning?" (2007, p. 1153). Fivush et al. (2006) describe this further as a style that uses many questions and statements, adding information to the discussion, and confirming and praising children's participation. This in turn plays an influential role in the child's retention and recall of information at a later stage (McGuigan & Salmon, 2004). Together, these components, based on the elaborative reminiscing technique, create a shared narrative between the parent and child and helped shape the child's memories.

Initial studies on parent-child conversations focused on talk after an event. However, the effect of elaborative talk before and during an event is less well understood. McGuigan and Salmon (2004) carried out a review of studies that explored the impact of children's adult-child talk *before* an event and the ensuing recall of each child. Prior knowledge and the degree to which these conversations influence children's memory is well known but a report of a study involving 5–7-year-old children is particularly significant in this study. Sutherland, Pipe, Schick, Murray and Gobbo (2003) argue that children within their study who were provided with specific information about an upcoming event were able to provide more extensive descriptions of the event than those children who took part in a general discussion about the topic. The higher achieving students were read an illustrated book and participated in specific discussions about the intended experience (Sutherland et al., 2003).

The value of parent/child discussions *during* an event has less clarity. In a comparative study, McGuigan and Salmon (2004) found that elaborative talk that occurred during an event, although playing a role in children's encoding of the event and drawing their attention to details of the event, appeared to have less impact on the richness of a child's memory than those discussions that occurred after the event. There was some uncertainty about the reason for this. However, Reese and Newcome (2007) argue that conversations during an event are often interrupted, and it is only afterwards that a parent may have time to engage in prolonged discussion. They conclude that "elaborative reminiscing may be uniquely important for children's memory of the event in part because a coherent and evaluative narrative is more memorable than isolated elaborative comments" (p. 1154). McGuigan and Salmon (2004) summarise the findings of several studies and conclude that the timing of conversations and the spacing between conversations will impact positively on children's recall. By engaging in talk with children about an event, describing the experience and naming items relevant to the event, children will be more able to understand and recall the event. An advantage is created where these conversations are repeated over time – in this study it tended to be before, during and after the event. In addition, they report on the work of Bahrick (2000) who maintains that "performance improves as a function of the spacing between two repetitions, a pattern found for infants, children, and adults" (McGuigan and Salmon, 2004, p. 670).

By over-laying the results of these studies onto the planning of a visit for five-year-old students outside the classroom, a number of useful considerations emerge, which could add value to students' experience and their ability to retain and recall information. The role of the parent-helper is a crucial one and by encouraging these parents to use open-ended elaborative questioning techniques with the students in their care, adding information, confirming their input and praising their participation, research suggests that the students' recall of events may be greatly enhanced.

2.2.6 Section summary

This section summarises some of what is known about educating students outside the classroom. It began by illustrating the changing nature of schooling, including examples of tribal education, the influence of the early Greeks and Romans, through to the present day and the development of the 2007 New Zealand curriculum. A constant theme throughout this section is the place education outside the classroom has held over the years. It also explored the concept of informal learning and concludes that 'free-choice learning' and 'perceived choice' learning offer the most accurate description of how these types of experiences are structured.

The Ministry of Education commitment to EOTC has been particularly influential and support has been provided to a wide range of educational enterprises to buy in education officers and to provide pre- and post-visit activities for classes. A further endorsement by the Ministry was the publication of the 2009 *EOTC Guidelines – Bringing the Curriculum Alive*, in which schools are encouraged to extend students' learning beyond the classroom and into the real world.

Included in this section is a more sustained focus on the characteristics of effective EOTC, in which salient points from a wide range of publications have been presented and which became the framework of the intervention model described in Chapter 4. These points draw attention to the management of a visit before, during and after the experience, the role of parent-helpers during the visit and strategies for ensuring a visit is both engaging and memorable.

2.3 Technology Education

2.3.1 Introduction

The implementation of technology education in New Zealand curriculum underwent a challenging and extensive period of research, professional development, programme trials and curriculum review, resulting in the publication of the 2007 curriculum, in which technology education was one of eight compulsory learning areas.

This section of the literature review begins with a brief reflection on the origins of technology – that capability of humankind that enabled the survival of our species through a period of severe climatic change. An overview of the philosophy of technology and the development of ideas that have formed and shaped the New Zealand curriculum is also presented. A final section describes the expectations teachers can have of five-year-old students experiencing technology education.

2.3.2 The origins of technology

Moiduser (2009) argues that technology "is a defining characteristic of humankind" (p. 392) and quotes Ortega y Gasset (1941, p. 96) in which he argues that "Man without technology – this is, without reaction upon his medium – is not man". In the mid-1970s BBC television series entitled *The Ascent of Man,* Jacob Bronowski, a British mathematician and biologist, referred to early man as "a shaper of the landscape", having "imagination, reasoning, emotional subtlety and toughness – not accepting the environment but changing it" (Gilling, Jackson, Kennard, & Paterson, 1973). Survival of early hominid species depended on their ability to adapt to changing climatic conditions, to draw on knowledge of the environment and available resources, which had been generated over time, and be guided by the cultural practices of the time, to solve problems and address their needs (Moiduser, 2009). The literature suggests that it was the ability of early species to combine the dual knowledges of "know-that", i.e. recognising that a problem exists, and "know-how", i.e. knowing how to solve the problem, that defines what it is to be human (Hope, 2009).

Renfew (2007) describes the comparatively recent field of cognitive archaeology – the archaeology of the mind – in which 'material engagement theory' pinpoints with greater accuracy that phase of human development during which individuals or communities "engaged with the material world through actions that have simultaneously a material reality and a cognitive or intelligent component" (p.123). Unlike earlier species, early humans illustrated their capacity to represent images of animals and objects of a pre-conceived form in the rock drawings and decorated artefacts discovered in several locations around the world (Mithen, 2007). Intentionally creating marks on objects suggests an intended communication with some "displaced event or object" (p. 181) other than the artist or craftsperson himself. This ability, not previously seen in the artefacts of earlier species, suggests the development of a cognitive faculty enabling the early human to formulate a mental model of an outcome, to plan, to choose and to make decisions. Hope (2009) argues that it was this ability to design that “is one of the defining characteristics of our species” (p. 51), which separates us as modern humans (*Homo sapiens*) from all other species including the hominids, e.g. *Homo erectus, Homo habilis* and *Homo ergaster* to name a few.

This line of thinking gives credence to Moiduser’s (2009) argument for the need to teach and learn technology from not only a socio-technological perspective but also from a cognitive/epistemological perspective. As inhabitants of the twenty-first century, we live in a “technology saturated” environment and there is a need to provide students with the knowledge and skills to equip them to participate in society as citizens who understand, and have experienced, technology as a field of human activity (Ministry of Education, 2007a). Additionally, if the views expressed above are seen as credible, Hope (2009) argues that it is worthwhile to introduce the concept of technological development early in a student’s education. In Australasia, children enter early childhood centres at the age of three or four years, with a predisposition to include technological practice within their collaborative play (Mawson, 2011). Specifically, and without adult supervision, these children can identify a need, they can find resources, develop a final outcome, and offer suggestions as to its fitness for purpose. In effect, these very young students are already responding to their natural desires to manipulate their environment. It is a natural continuation, therefore, to develop programmes for primary education that acknowledge and build on these students’ pre-school experiences by providing them with the skills and opportunities to experience and experiment with the ‘made’ world of which they are a part.

In summary, the field of cognitive archaeology, and particularly the work of Renfew (2007), helped inform this investigation into the origins of technology. The development of a cognitive faculty enabling the early human to formulate a mental model of an outcome, to plan, to choose and to make decisions is believed to be a primary driver within human evolution and the survival of the species. This has provided the conceptual foundations for, and, in many ways validated the place of technology and design in the curriculum. Exploring technology as a domain in its own right, and the philosophy that underpins this is explored in the next section.

2.3.3 An overview of the philosophy of technology

The relatively ‘young’ philosophy of technology, which informs technology education in the New Zealand curriculum, has its roots in the more established scientific discipline that aims to gain insight into the nature of reality as it applies to scientific knowledge and theory. De Vries (2005) compares the philosophy of technology with that of “a mosaic (made up) of many different ideas and suggestions” (p. 7). Of particular significance in the practice of technology and technological development, the focus of this study, are the divisions described by Carl Mitcham in his book entitled *Thinking through Technology*. Mitcham (1996) identifies four categories for examining technology and these are illustrated in Figure 2.1: technology as objects or artefacts, technology as knowledge, technology as activity, and technology as volition – activity that is fundamental to being human. These categories are widely accepted and form the basis of a number of scholarly publications, for example, de Vries (2012) describes the same categories but with a substantial focus on values as opposed to volition. His publication with Jones and Buntting (Jones, Buntting, & de Vries, 2013) investigates this fourth category with the holistic classification of ‘technology as a characteristic of humanity’. This is a useful theme for discussion within this study as inevitably the core values of the students and their families become part of the story being told, what represents good and bad, what is appealing, and what is considered to be distasteful.

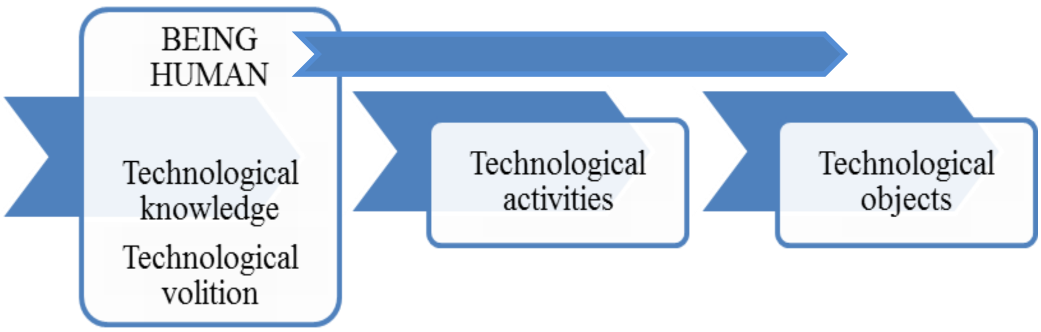


Figure 2.2 Modes of manifestation of technology (Mitcham, 1996, p.160)

2.3.3.1 Technology as artefacts

Experiencing technology as artefacts is often the first encounter a student has with the concept of technology. However, the term has undergone considerable scrutiny in recent times, and it is helpful to clarify how it is used within this study (Frederik, Sonneveld, & de Vries, 2010). Taking into consideration the work of Dipert (1993), in which he analyses what is meant by technical artefacts, Mitcham (1996) and the more recent work of de Vries (2005), and Jones, Buntting and de Vries (2013), where the authors reflect on the "developing field of technology education" (p. 1), an artefact is described as an object, natural or man-made, which has been modified in order to serve a specific purpose, or, as in the case of a hybrid product, multiple functions. This view is reflected in the New Zealand curriculum, Level 1 in which the 'Nature of Technology' is described with the characteristics of technological outcomes expressed as "products or systems developed by people (which) have a physical nature and a functional nature" (MoE, 2007, p. 47). Mitcham (1996) argues that " artefacts (are) meant in some way to be lived with, used, lived within, operated, or set in motion" (p. 162). The purpose or function of the artefact may be altered by the user, necessitating the 'designer' to consider any possible abuse or misuse of the artefact. Children's toys are a good example of this. The plastic scooter of a three-year-old is designed for reasonably sedate, if not cautious use. The scooter the adventurous nine-year-old uses in attempting to 'scooter' down a flight of stairs will require a more robust design in order to cope with the additional weight and battering that it will receive.

Technology as objects or artefacts tends to be one of the first things that come to mind when people talk about technology (Frederik et al., 2010; Mitcham, 1996). Currently this includes electronic devices such as computers, cell phones, iPods, iPads and other multi-media devices. De Vries (2005) reports on several empirical studies in which students appear to have an "artefact-oriented view of technology" (p108), and in which the human and social elements of technology appear less well understood. Educationally, it seems relevant to build on these understandings, particularly as technology education in New Zealand schools is structured around the design, construction and evaluation of a range of technological outcomes.

The dual nature of an artefact, described as physical and functional, is also recognised by a number of scholars (de Vries, 2012; Meijers, 2000; Mitcham, 1996). The physical or structural nature of an artefact concerns its physical properties, and information about the size, shape, weight, smell, material and composition of its make-up (de Vries, 2005). The purpose or function of the artefact may not necessarily be determined by its physical nature as this represents a range of more abstract concepts, including not only what the artefact does, but also its usability (Jones et al., 2013), whether it can be recycled, if is it made from sustainable materials, and whether producers uphold ethical practices in regard to issues such as child labour, animal testing, safe working conditions and so on. A further level of detail is described by the Dutch philosopher Herman Dooyeweerd in which he identifies 15 ‘aspects of reality’ within which an artefact has to function, (Dooyeweerd, 1955) for example, in a spatial aspect of reality, a linguistic or symbolic reality, an economic aspect, and a social, juridical, aesthetical, ethical and belief aspect (de Vries, 2012, p. 23). De Vries argues that in order to achieve the desired function and consumer appeal of an artefact, a designer needs to be conscious of each of the 15 aspects, and the potential impact they may have on how the artefact will be judged by consumers. Several of these “aspects of reality” have been introduced into the New Zealand curriculum, particularly at senior level, but may also be identified within the practice of young students. For example, the Level One technology curriculum learning intentions refer to technological modelling, the characteristics of technology and the characteristics of technological outcomes, each of which have the potential to address elements of Dooyeweerd’s list (1955).

2.3.3.2 Technology as knowledge

A second category of the nature of technology is technological knowledge, and this according to Mitcham (1996) has undergone the most scrutiny of all four categories. Based on the early work of philosophers such as Plato, through to Descartes, Locke, Hume, and Kant in the fourteenth and fifteenth centuries, and more recently to Nietzshe, Cassier and Heidegger, epistemologists have attempted to analyse knowledge but it transpires that no generally agreed-to analysis has been accepted (de Vries, 2005). Most attention has been focused on Plato’s description of knowledge as *justified true belief* – a statement or proposition, e.g. eating red berries is dangerous, which when justified through experience, credible literature, or source of knowledge, must be true (de Vries, 2005). Plantinga (1993), in his book entitled *Warrant: The Current Debate* argues for a more complex definition and, in addition to what a person believes, and their justification for this, he states:

> The person's belief is a result of proper functioning cognitive faculties (they function according to their design plan). They function in an environment that is suitable for their proper functioning and the design plan for the cognitive faculties was a good plan (Plantinga, 1993, p. 30).

Baird (2002) cautions that knowledge changes, and propositions that are accepted as being true now may well be abandoned in future years. He also reminds the reader that a proposition that holds true in one context cannot be relied upon in another context. What constitutes an appealing colour in a product is a useful example of this idea. Blue is a very popular colour for shading a wide number of products, but the use of blue colouring in a food product is usually perceived as being unappetising. De Vries (2012) argues that technological knowledge is very context specific and is less likely to be generalisable because of the individual nature of each design problem (de Vries 2012).

Despite clear links to technological knowledge in Plantinga's (1993) definition, namely the reference to design plans and proper functioning, there is technological knowledge that cannot be expressed as propositions. Gilbert Ryle (1945) raised the distinction between *knowing what* and *knowing how,* and in his presidential address to the Aristotelian Society in 1945, described *knowing-how* as "When a person knows how to do things of a certain sort, his knowledge is actualised or exercised in what he does, … his performance is in some way governed by principles, rules, canons, standards or criteria" (p. 8). Knowing how to construct something, therefore, is about knowing the steps to take, the materials to use, so that together, as more recently stated by Baird (2002), the item successfully accomplishes its intended function. Baird describes this as 'thing knowledge' – "an epistemology where the things we make bear our knowledge of the world, on a par with the words we speak" (p. 1). Ancient machinery, such as the water wheel developed in China in the second century BC, exemplifies this. The designers and builders of the time would have been unaware of the science that explained how and why the water wheel worked the way it did, only that, through experience and experimentation, the combination of materials and components, the upright positioning of the wheel and the working environment did work. This acquisition of skills and practical knowledge over time illustrates the ‘knowing-how’ type of knowledge described by de Vries (2005). This inverted process still has relevance today and de Vries (2012) refers to it as ‘experience-based technology’ in which “designers come up with designs without exact knowledge of how they work” (p. 21). The resulting artefact can lead to understandings about the technological application of scientific principles and may guide further modification and/or improvement of the product design. The tungsten-halogen lamp, initially based on an earlier model patented in 1893, was further developed by Alton Foote and his colleagues during the early 1950s. With the collaboration of a group of friends and colleagues, a model was eventually developed in which the previous blackening of the interior surface was reduced, and until very recently, this same product, having undergone many successful innovations and modifications, has remained in use.

Another strand in this analysis of what constitutes technological knowledge is that it is knowledge that can only be expressed adequately in the form of sketches and drawings (Ferguson, 1991). Ferguson refers to this as knowledge of ‘the mind’s eye’ – knowledge that needs to be visualised. This cannot be easily represented in the form of propositions; it can be complex, multi-layered and dynamic in its initial stages. Equally, depending on the experience and expertise of the designer, it can be simplistic and limited in the detail provided, as would be found in the design drawings and/or functional modelling of a novice designer or, of relevance in this study, the drawings and models of a child.

An interesting and perhaps less well recognised element of technological knowledge links to the previously discussed dual nature of artefacts – the physical and functional nature of an artefact, and the relationship between the two. This pertains to the knowledge of how to make a product and the processes or steps involved in enabling the product to function. This relationship is often referred to as the principle of operationalisation, in which the designer can bring together his/her knowledge of materials and material properties, construction techniques, how the product should function, and how it might present, i.e. the aesthetics of the product. De Vries (2012) makes a further distinction between physical and functional knowledge by describing physical knowledge as “knowledge of things as they are" (p. 36), as opposed to functional knowledge about which Jones et al. (2013) state, "Knowledge of the function of an artefact is not about what they actually do, but rather what they ought to do" (p. 193). For example, an elite racing bike that has been damaged and sent for repair will present a challenge for the mechanic. The mechanic knows not how the bike currently functions but rather how it should function. This would require taking into consideration many design elements which are not usually relevant in the construction of a mountain bike, for example, which needs to sustain heavy jolting and vibrations, or a commuter bike for which comfort is a key factor. Instead, knowledge specific to the design and function of a racing bike needs to inform the type of repair carried out by the mechanic. This type of knowledge is known as normative knowledge and is defined by the rules, standards or beliefs that govern the construction of that particular product. De Vries (2005) elaborates further, explaining that the application of normative knowledge is "both effective and efficient, but not true or false, at least not in a realist account of knowledge" (p. 32). Normative knowledge can be specific to one product or it can be applied more generally to a range of products or product types. For example, the technique employed for applying paint to the frame of a range of different types of bikes would be relatively constant, whereas the selection of materials to construct each model would rely heavily on how it was expected to function.

Finally, there is a social impact upon technological knowledge, which is referred to by de Vries (2012) as "social agreement" (p. 20). Cheek (2012) describes this as "the social forces – which embody particular technologies within particular cultures at specific time periods" (p. 172). The cultural beliefs, traditions and desires of individuals and social groups are believed to determine how new technologies are devised and developed. In contrast to this is the Actor Network Theory (ANT), which builds on these same ideas, recognising the influence that humans have on the development of technologies, but also arguing for the role that manufacturing systems and corporations play in dictating the "direction, scope, and pace of technological change" (2012, p. 172). Furthermore, consumers have expectations of the products they purchase and they too can exert influence on standards of production and the quality of products on sale by purchasing or not purchasing the product and by exercising their right of complaint. Similarly, technologies that are presented to the marketplace can also influence the choices that consumers make and impact positively or negatively on their quality of life. An example of this is the recent modification in the design of children's school bags. Many designs are available with small wheels added to the bottom of the bag whilst others include wide shoulder straps to improve comfort, and waist clips to hold the bag more securely to the smaller frame. These design changes are promoted as a measure to counteract the back and spinal injuries caused by children using overweight backpacks (Bass, 2009).

Several elements contained within the previous discussion can be recognised within the New Zealand technology curriculum, specifically within the Technological Knowledge strand of the curriculum. In this strand, students are encouraged to investigate technological products, their materials and material properties, along with modelling and technological systems. A third strand entitled the Nature of Technology frequently overlaps with this and aims to guide students in considering the impact and influence society has on technological developments.

2.3.3.3 Technology as Activities

A third category that further defines the nature of technology is technology as activities. De Vries (2012) identifies these activities as (i) designing, (ii) making, and (iii) using and/or appreciating processes (p. 22). This category of technology as activities, aside from that of design and designing, has not been well recognised in the past, and little has been written about it. Harrison (1978) maintained that within the philosophy of action, "ideas of designing and constructing (except perhaps in somewhat specialised mathematical and related contexts and senses) figure rarely ... and the no less interesting notions of building, cobbling (patching) and bodging (repairing without the correct materials) not at all" (p. 1).

(i) Designing

Design and the process of designing a product is a key component of technology education. In amongst the discussions concerning technology, technological practice and technology education, much of what is written concerns the design process (de Vries, 2012). Design is defined in a number of ways depending on whether it is considered to be an idea, an aspect of knowledge, a project, a product or even a way of being (Mitcham, 2001). It may describe a preliminary outline or drawing for something that is to be made, it may describe a period of time, for example the Arts and Crafts movement of the late 1800s, or it may describe a process of product development from initial concept through to final realisation.

In his paper, Dasein Versus Design: The Problematics of Turning Making into Thinking, Mitcham (2001) explores the origin of design and redefines the activity in terms of traditional and contemporary practice. In traditional life, the artisan worked with local materials to conceive, make and then use the artefacts of everyday life. Design was hidden amongst this continual making and using process. Mitcham described it as, “an intuitive trial and error fabrication, letting oneself be guided by materials, tradition and personal relationships in the community” (Mitcham, 2001, p. 30).

After the rise of mechanisation during the nineteenth century, the need for a “designer” emerged to develop the form or specifications for artefacts and also to construct patterns for their mass production (Mitcham, 2001). This brought about a new breed of art worker, who translated the ideas of fine artists into products that were able to be mass-produced. It also heralded a new class of engineering worker, who designed the mechanical, chemical, electronic, molecular or genetic structures of products. The unplanned, trial and error of dasein, was transformed into the planning and problem-solving of contemporary design (Mitcham, 2001). The design tasks of the engineer and/or technologist may emanate from a range of sources, i.e. the result of ‘blue skies’ research, the mission-oriented knowledge gained through the research and development wing of a company or most commonly, as a result of a commissioned project. In all cases, the task of the designer begins with a desired function, and results in a physical outcome that can realise this function (de Vries, 2012). The process is a hugely varied and complex one, with few commonly agreed pathways. Iterations during the process are the norm, and the all-important knowledge about consumers in terms of who they are, what they want and how they will use the product, is difficult to ascertain. The previously used example of the child’s scooter is a good example of this. It is not until a child becomes a competent user of a product that (s)he may begin to use it in a more experimental, thrill-seeking manner, which may extend far beyond the original intent for the product. Knowledge of the consumer and how a product could be used is the ultimate challenge for a designer and one international design company charges its employees with not only understanding the market and the client, but also observing real people in real-life situations to find out what makes them tick, what confuses them, what they like, what they hate, what latent needs are not currently addressed, visualising new-to-the-world concepts and customers who will use them, and finally, evaluating and refining prototypes in preparation for commercialisation (IDEO, 2014).

From the above descriptions it is clear that often the production or making of a product is explained as an integral part of a ‘design process’. However, there is another level of practice that describes production in greater detail, which can take several different forms, i.e. it can be a manual process, a mechanised process or a fully automated process (de Vries, 2012). There is a wide spectrum of activities that de Vries summarises under the three headings of transformation of materials, energy and information, which may include design of the production process, tooling, testing, and maintenance of equipment. These same three categories are used to provide guidance to teachers of technology when selecting contexts and issues for teaching technology in the classroom. The intention is to ensure that students experience a wide range of technological activities during their time at primary school (MoE, 2007).

Trends exert a significant influence on the designer and consumer, and on product outcomes. Green-design, or environment-conscious design in which the whole lifecycle and recyclability of a product is taken into consideration, is one that has emerged in recent times. For example, the new Anchor light-proof milk bottle is promoted in New Zealand as being made from high-grade, recyclable HDPE plastic, which can be used in the production of recycling bins, slip sheets, cable covers, pipes, drainage coils and more. This is appealing to many consumers who consciously seek out products with components that can be fully recycled, although the environmental and economic costs involved in many of these recycling processes is still highly controversial.

(ii) Making

Mitcham quotes one of the earliest descriptions of making as described by Aristotle in the fourteenth century when he made a distinction between cultivating and construction – cultivating being that which helps nature "to produce more perfectly or abundantly things that she could produce herself" (Mitcham, 1996, p. 211), as opposed to constructing, which involves "reforming or moulding nature to produce things not found even in rare instances" (p. 211). A more recent perspective is the notion of soft technologies and hard technologies. The former are those that work in harmony with nature and often depend on renewable resources, and the latter "depend on conditions not found in nature" (p. 212) and draw on resources that are non-renewable, for example coal, oil and gas (Mitcham, 2012).

Mitcham (1996) positions the notion of 'technology as activity' as being fundamental to the successful merger of knowledge and volition during the development, or use of an artefact. He identifies two categories of activity – action in technology, which may include crafting, inventing and designing; and processes in technology, which may include manufacturing, working, operating and maintaining equipment. The three categories described by de Vries (2012), which have the potential to encompass many of those described by Mitcham, perhaps have greater relevance within education and specifically within the technology education curriculum. These three components are easily recognised in the curricula of many European countries, where the elements of authentic problem-solving and design are constant, and the broad themes of technological understanding, technological capability and technological critique are generally included (Fensham, 1991). The same three elements can be recognised in the Technological Practice strand of the New Zealand technology curriculum, within which planning, brief development and outcome development and evaluation are listed. They can also be recognised in the Nature of Technology strand, in which the characteristics of technology and technological outcomes are included.

(iii) Using and/or appreciating processes

The final element of 'technology as activity' identified by Mitcham (2001) is described as using and/or appreciating processes. There are several variations and connotations associated with the term "to use". However, in a technological sense, it generally applies to an object or artefact that is "put into service or action", for example, a screw-driver used to insert a screw into a piece of wood or an iPhone used to send a message. Again in technological terms, it is 'the user' who is responsible for how the product is used, whether or not this was the intention of the original designer, and whether or not it was ethical or even legal. For example, the use of an iPhone to access social media for the sole purpose of cyber-bullying is currently being legislated against in New Zealand under the Harmful Digital Communications Bill (Justice and Electoral Committee, 2013). The extent to which cyber-bullying has occurred amongst young people appears to have been unexpected, and not planned for. Whilst the technical uses of the iPhone were meticulously calculated by Apple designers, along with the ease with which the user could make use of the technical functions, the purpose or end use to which the technical functions were put exceeded general expectations and have retrospectively required governmental intervention to control inappropriate behaviours. Clarifying the desired function of a product, and comprehensively investigating its possible use (or misuse) by consumers, plays a very important role in product design. This links strongly with the following discussion about the characteristics of being human and the philosophy of volition as it applies to technology.

2.3.3.4 Technology as a characteristic of humanity

In his book *Man and Technics*, Oswald Spengler, a German historian and mathematician, stated "Technics is not to be understood in terms of the implement. What matters is not how one fashions things, but what one does with them; not the weapon, but the battle" (Spengler, 1931, p. 9). This quotation signals several elements of the following discussion, i.e. that whilst the previous discussions have been situated around technology as artefacts or activity, technological development does not occur in isolation and is influenced and, at times, controlled by many external forces, namely the value or volition that individuals, groups or societies attach to an artefact, and the resulting interest, motivation and acceptance that can be generated (Mitcham, 1996).

The changing conception and promotion of dark chocolate as a health food rather than as confectionery is a good example of this (Becket, 2008). The consumption of dark chocolate has gradually gathered momentum over the last three or four years, after initially gaining little interest from the usual chocolate consumer. Once promoted for its health-bearing attributes and the use of sustainable ingredients, it has gained attention from the health food market and sales have increased, albeit with a different group of consumers (WWF-Australia, 2011).

Technology or links to technology have been represented in the mainstreams of philosophy, specifically those of the Continental philosophers – that group of philosophers whose work is based on the nineteenth and twentieth century European philosophers. Continental philosophy includes a number of different movements and four of these are particularly relevant to this discussion, namely the phenomenologist movement, the critical theorists, the pragmatist movement, and those who base their philosophy on a religious point-of-view, referred to as reformational philosophers. Mitcham explores the philosophies emerging from each of these movements through an over-arching theme of volition – the power or ability to decide something for oneself, to take action to get what one wants, or the act of exercising the will to make conscious choices or decisions. According to the work of Spengler, Mumford, Grant, Skolomowki and other twentieth century philosophers, this can be realised as either the will to survive, to satisfy, to control, or the pursuit of freedom, efficiency and other self-concepts (Mitcham, 1996). The notion of volition works hand-in-hand with the core values held by individuals or groups of people or by an entire society. Philosophically these values are influenced by the view of reality that is held by each individual as they engage with technology, their values of what represents good and bad, and their perception of aesthetics, i.e. that which is visually appealing or distasteful (de Vries, 2012). It is not surprising to also note that the knowledge an individual brings to occasions of technological decision-making will impact significantly on the final outcome that is developed, or as a consumer of a product, in its use or general acceptance. Mitcham (1996) describes this ability as acquiring 'intelligent control', which he believes depends on three ideas:

> Knowing what we should do with technology, the end or goal towards which technological activity should be directed; knowing the consequence of technological actions before the actual performance of such actions and acting on the basis of, or in accord with, both types of knowledge (p. 260).

The term 'incontinence' has been used by Mitcham (1996) to describe a weakness of the will whereby, despite knowing what should be done and how it should be done, a person may elect, for any number of reasons, not to do it. For example, the danger of cycling is well-known, as is the value of wearing safety equipment such as high visibility vests and safety helmets. Despite this, and until legislation was passed in 1994 making the wearing of helmets compulsory in New Zealand, many cyclists avoided wearing helmets and put themselves at serious risk of brain damage when involved in a road accident. This level of ‘incontinence’ is generally based on feelings of discomfort, the cost of safety equipment, and frequently self-image – wearing a helmet was not considered to be in vogue. The use of Hormone Replacement Therapy [HRT] is another example where some women and their physicians weigh up the risks of its use against the possibility of developing breast cancer or continuing with the on-going disruption to their lives caused by symptoms of menopause. The additional risks of breast cancer are very low, and the suffering experienced by some women is extensive. Drawn from the work of Plato and Aristotle, this is described by Mitcham as the strong version of incontinence, in which there is an “opposition of intelligence to intelligence … to at once know and reject” (Mitcham, 1996, p. 260).

Heidegger, a German philosopher best known for his existentialism and phenomenology-based inquiry, wrote extensively through the early to mid-1900s and was less than positive about modern technology. In his analysis of Heidegger’s work, Mitcham explains, “Whereas pre-modern technology cooperated with nature to bring forth artefacts, modern technology imposes on nature, forcing it to yield up materials and energies that are not otherwise to be found” (Mitcham, 1996, p. 257). Furthermore, Heidegger describes the natural environment as having become a resource – a native tree becomes a resource for supplying wood, rather than a beautiful part of our natural world. (The concept of ‘sustainable development’, a phrase made popular by the Bruntland Commission report in 1987 (Burton, 1987) and which is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” was not articulated at this time and the point being argued, along with its example, now appears dated and short-sighted).

In his publication *The Question Concerning Technology*, Heidegger also argued for maintaining a level of detachment from technologies, as in certain conditions humans can become enslaved to many of the devices they have available to them (Heidegger, 1954). This is particularly relevant to our lives in the twenty-first century with the extensive use of smart phones, iPads, tablets and other digital technologies. I have observed students in my technology classes who become agitated if they are prevented from being in physical contact with their phones, sometimes this is merely resting their little finger on the screen. As a technology, metaphorically, it becomes an extension of their body. The notion that although such devices are considered to be indispensable, maintaining this level of detachment will enable the user to remain in control of the technology, rather than the technology dictating or dominating the will of the user. Based on a similar premise, Borgmann, a contemporary of Heidegger, saw technological devices positioned between the user and reality, resulting in a reduced engagement with reality. He used 'the hearth' as a central focus of a pioneer's home as an example that unites a family around a set of traditional skills and practices – the stove, the cutting of wood, the fire, and the tasks assigned to various family members in order to warm the home and cook the food: "It provided for the entire family a regular and bodily engagement with the rhythm of the seasons that was woven together against the threat of cold and the solace of warmth" (Borgmann, 1987, p. 42).

Borgmann describes this as the device paradigm or push button technology, where many of the procedures traditionally carried out in order to collect water or heat a room have become obsolete and in many instances impossible or, with higher populations, damaging to the environment. For example, it is no longer possible for communities to collect their own supply of wood and burn it on an open fire without creating extensive pollution and stripping the environment of its forest (Borgmann, 1984). He strongly advocated for the revival of, and engagement with, all those activities that maintain a greater connection with his view of reality – growing your own vegetables, cooking a meal, craft-making, jogging or fishing – activities that he described as focal activities and that continue to be highly valued amongst some communities.

Another phenomenologist (or more accurately post-phenomenologist) whose work has been particularly influential in the field of technology is Don Ihde, an American philosopher of science and technology. Ihde (1990) identified four relationships between us and reality, the embodiment, the hermeneutic, the alterity and the background relationships. Each of these relationships describes an optimistic view of the way technology impacts on our lives and our view of the world. The embodiment relationship refers to technological devices such as hearing aids, glasses, or pace makers, through which the wearer experiences the world as though each device is a part of their body. The hermeneutic relationship describes technologies such as an MRI scan whose resulting pictures require interpretation in order to be fully understood. The alterity relationship, as suggested by the term, refers to technologies that alter reality such as in science fiction movies and computer games, e.g. Play Station 3 offers an iPet that children can groom and play imaginary games with. The fourth category, the background relationship, refers to technology that we are not aware of, and which alters our perception of the world around us, i.e. technologies that project light, noise or smells. Light pollution is a well-known example of this. The Aoraki Mackenzie region in the South Island of New Zealand was awarded gold-tier status as a Dark-Sky reserve (University of Canterbury, 2014) because of the absence of artificial sources of light, which interfere with the clarity of the night sky. This category of pollution may exist without being noticed and yet is able to influence the perceptions and lived reality of the individuals and families in the region. Ihde (1990) acknowledges that technological artefacts have the capability to shape our view of reality, and at times, to blur the distinction between what is natural and what is artificial. Whilst it is widely accepted that the inclusion of technologies within our lives is enriching and offers opportunities to extend our capabilities far beyond what would normally be possible, Ihde argues that it is important to be mindful of *how* technology influences the way we view the world as, if we are not, misunderstandings can develop (Ihde, 1990).

A third philosophical movement, which is included briefly in this discussion, is critical theory, because this shifts from Ihde’s focus on an individual’s perception of reality to a social dimension of reality. De Vries (2012) explains that “philosophers in this stream show how technology impacts society and the other way around” (p. 25). This philosophy can be seen reflected in the third strand of the New Zealand curriculum – the Nature of Technology. Critical theory is a theoretical tradition that has its roots in the period directly following the First World War. It is emancipatory in nature – researchers set out to interrogate, engage with and act upon issues that constrain or exploit minority and marginalised groups (A. Cohen, Manion, & Morrison, 2007b; Guba & Lincoln, 1994; Lemesianou & Grinberg, 2006). Andrew Feenberg, a critical theorist in the democratising of technology, has written extensively about technology and argues:

> What human beings are and will become is decided in the shape of our tools no less than in the action of statesmen and political movements. The design of technology is thus an ontological decision fraught with political consequences. The exclusion of the vast majority from participation in this decision is profoundly undemocratic (Feenberg, 2002, p. 2).

Feenberg uses the French Minitel system as an example. This system was a forerunner to the Internet, which was initially set up by technocrats of a large French telephone company to improve citizen access to information. Hackers from outside the company realised the potential for human communication and forced this to eventually become one of its central functions. This 'democratic transformation' of a technological system provides a model of technological development, which Feenberg envisions as two steps. The first step involves a sociotechnical problem, which, initially separated from its social context, is solved by the engineer. The second step involves the engineer's solution being returned to its social context and modified or even adapted by the user (Feenberg, 2002) as in the Minitel example. This notion of shaping technology at a social level (Jones et al., 2013) is a key idea within modern technological development and is also signalled very strongly through the New Zealand technology curriculum. For example, at its most embryonic stage, Feenberg's ideas are introduced through the level two learning intention headed Characteristics of Technology, which states "that students will understand that technology both reflects and changes society and the environment and increases people's capability" (Ministry of Education, 2007a).

A further, though no less influential group within the philosophy of technology, is the Pragmatists or realists movement, which contends that "what is done in technology should be determined by what is successful in practice not by a priori beliefs or ideologies" (Jones et al., 2013, p. 194). Larry Hickman and Joseph Pitt have published extensively in this area and Hickman, who is the director of the Center for Dewey Studies and professor of philosophy at Southern Illinois University Carbondale has used the ideas initially mooted by John Dewey about learning by experience and applied them to technological developments (de Vries, 2012). Hickman argues for the model of social decision-making used by those engineers who do not have preconceived ideas about the form a device or structure should take, but rather follow an established process of investigating, evaluating and developing solutions (Hickman, 2012).

Marc de Vries, who has been and continues to be influential in the development of New Zealand technology education, aligns himself with another stream of philosophy referred to as reformational philosophy. According to de Vries (2012), this has “contributed to developing ideas about the nature of technological developments and moral values in technology” (p. 26). Riessen, a professor at the Institute of Technology of Delft in the 1950s, and later Schuurman, another second generation reformational philosopher also based in the Netherlands, (Schuurman, 2015) developed ideas concerning technology as a process, with Schuurman cautioning against motives such as “lust for control” and promoting that of “care and stewardship”, behind the development of new technologies (de Vries, 2012, p. 26). Schuurman argues: “We continually encounter more problems in which the technological worldview and its befitting ethics fail us. It is clear from problems concerned with sustainability” (Schuurman, 2002, p. 11). Leo Elshof presents a particularly strong stance on this issue and in his 2009 publication *Technology Education and the Environment* maintains that “technology education has a greater responsibility in terms of its orientation to sustainability issues and the responsible use of its subject that any other subject in the curriculum” (Elshof, 2009, p. 233). Whilst the New Zealand curriculum advocates an across-the-curriculum concern for the environment and issues of sustainability, there is little research to suggest that this is being enacted in the classroom (Elshof, 2009).

2.3.4 Technology Education in the New Zealand Curriculum

Technology Education in the New Zealand curriculum is a key context for this study. This section aims to investigate the origins of this curriculum and to establish how it has evolved into its most recent iteration outlined in the 2007 curriculum. A detailed account is provided, highlighting the elements of the curriculum that are most relevant to this study. The four characteristics of technology outlined previously in Section 2.3.3, technology as artefacts, as knowledge, as activity and as a characteristic of humans, are presented as the foundational ideas behind the achievement objectives of the curriculum. With the focus of this study being on the learning experiences of five-year-old students, particular mention is made of teaching and learning goals for Level 1 students and the links that the New Entrant teacher is able to make to the Early Childhood curriculum, *Te Whaariki* (Ministry of Education, 1996).

2.3.4.1 The origins of the New Zealand technology curriculum

The development of the technology curriculum in New Zealand has its origins in technical education. This was established very early in the colonial period when a national school system was first introduced. Although missionary schools and village schools were flourishing in the 1830's, it was not until 1877 when the New Zealand Education Act was passed, that free, secular, and compulsory education for students from seven to 12 years of age was established (Dakin, 1973).

Technical education was introduced some time later offering metalwork and woodwork for boys, and cooking, needlework and/or laundry for girls. These skills were taught during a student's final two years of primary schooling – typically at around 10 to 12 years of age. At the same time, technical high schools were introduced with the intention that students would stay on at school, instead of leaving once they had completed Standard 6 (usually as a 12-year-old) and pursue their education for a longer period of time. It was believed that these schools would also provide an element of social control for a growing, unruly element of young people with little to occupy their time once they had left school.

The technical high school originally tended to cater to the needs of a growing population of middle class families, who struggled to find suitable home-help and skilled labour for their homes and properties. The new schools aimed to channel working class children into manual and trade employment to satisfy this gap. After 1945, common core subjects such as metal and woodwork for boys, and cooking and sewing for girls, were introduced in all high schools for third and fourth form students – generally students from 13 to15 years of age (Jones, 1997). During the 1970's and the 1980's, the beginnings of a new focus on design emerged in the classrooms of technical teachers, and subjects such as workshop technology, design and graphics and a 'design cycle' approach employed in the home economics subjects were becoming accepted (Jones, 1997; McKenzie, 1992). This change of emphasis, although not wide-spread, continued up until the time of the first technology education curriculum of 1995. Despite the changes, many teachers continued to offer a skills-based and limited programme, which failed to embrace the changing needs of a modern New Zealand society. These issues are still being addressed today.

Jones and Carr's (1992) critique of a wide range of international technology curricula during the 1990s, prior to the publication of the first technology curriculum, enabled New Zealand to replicate many positive features, develop some further, and disregard others. Proposals for implementing the first New Zealand technology curriculum were formulated with the unique needs of the New Zealand educational environment in mind. It was presented as a stand-alone subject, which could be integrated with other curriculum areas. A key element of its implementation was ensuring that technology education had equal status with other subjects such as science and social studies, by incorporating a high level of intellectual rigor into its programmes. The intention of the writers was that technology education should be identified as a subject quite distinct from the original technical and technicraft subjects. The inclusion of technology education into the National Certificate of Education Achievement (NCEA) for senior secondary students has gone some way towards achieving this. Technology has been listed as a possible prerequisite subject for entry into first-year university engineering studies which enables this position to be consolidated.

The learning theories upon which the New Zealand curriculum was based pointed to a curriculum that was to be pupil-centred, drawing on models of apprenticeship (Rogoff, 1990), situated cognition (Brown, Collins, & Duguid, 1998) and learning through participation in communities of practice (Lave & Wenger, 1991). Technology in the New Zealand curriculum was viewed as a human endeavour. The strengths and weaknesses of student performance were to be judged by the degree to which they could operationalise the three dimensions of the curriculum – technological practice, technological knowledge and the nature of technology (Ministry of Education, 2007a).

An extensive international literature review was a crucial part of the development of this curriculum and the philosophy, and many of the themes and objectives discussed in the previous section, can be seen reflected in its content. As is evident in the definition of technology education below, this curriculum was to offer far more than the technical competency of the traditional technical subjects, it was also to develop a practical capability for citizenship (Compton, 2001). At the time, the Ministry of Education defined technology education in this way:

> Technology education is a planned process designed to develop students' competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of a technological society (MoE, 1995, p. 7).

Students were to be provided with the opportunity to study in a range of technological areas, and the focus of their work was to be positioned in a variety of relevant and authentic contexts (MoE, 1995). Achievement objectives under the headings of technological knowledge, technological capability and technology and society provided guidance for teacher planning. When considered together, they were to give a structure for students' technological practice; it was to be "the vehicle that would enable students to develop their technological literacy" (Compton & France, 2007, p. 2).

2.3.4.2 The 2007 New Zealand technology curriculum

In 2007 with the introduction of the new schools curriculum, there was a change of emphasis. In the New Zealand Curriculum Stocktake report undertaken in 2002 by the Ministry of Education, it became apparent that an uncertainty around what constituted 'technological literacy' existed, and the technology community as a whole struggled to come to common agreement about this (Ministry of Education, 2002). Compton and Harwood (2004) reported that where classroom programmes "focus on developing students' understanding of and about technology almost exclusively within the context of their own technological practice" (p. 160), the level of critical analysis required for informed decision-making lacked the breadth and depth anticipated by the 1995 curriculum. This concept is exemplified in the research of Elmose and Roth (2005) in which they explore the notion of citizens' active participation in a society dominated by technological and scientific advances. These advances were recognised as having the potential to present unforeseen and uncontrollable risks, for which populations were generally unprepared. Their publication, *Allgemeinbildung: readiness for living in a risk society*, describes the example of the deterioration of the water supply in a rural area in Canada. As the community became increasingly urbanised, pressure on the available groundwater increased and the quantity and quality of the available water degraded. The situation was solved, not because of a reliance on expert advice and scientific method, but as a result of input from those most closely effected, their understanding of historical events that led up to the problem, their willingness to challenge local government reports, and the specific knowledge of community officials and advisors (Elmose & Roth, 2005).

The aim of the 2007 curriculum is to develop programmes that will foster "a broad technological literacy that will equip (students) to participate in society as informed citizens and give them access to technology-related careers" (MoE, 2007, p. 32). Furthermore, emphasis is placed on the practical nature of technology education, which should include developing models, products and systems, as well as appreciating technology as a field of human endeavour (MoE, 2007). This is communicated in the following definition:

> Technology is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative (MoE, 2007, p. 32)

Technological practice remains a key part of this curriculum and is described by three sub-headings or achievement objectives, namely planning for practice, brief development and outcome development and evaluation. There are two additional strands entitled Technological Knowledge, which includes technological modelling, technological products and technological systems, and the Nature of Technology, which includes the characteristics of technology and the characteristics of technological outcomes. The influence of Mitcham's philosophy of technology as artefacts, as activity, as knowledge and as volition is clearly evident in Table 2.2, borrowed from Compton's publication, *Yep – We can do that (Compton, 2009)*. Technology as activity is clearly developed through the

Technological Practice strand, technology as volition and as artefact is achieved through the Nature of Technology strand, and technology as knowledge, as indicated by its title, is explored through the Technological Knowledge strand.

Table 2.2 Technology Curriculum Constructs in the New Zealand Curriculum (Compton, 2009)

Technological practice	**Nature of Technology**	**Technological Knowledge**
Brief Development *(Technology as Activity)*	Characteristics of Technology *(Technology as Volition)*	Technological Modelling *(Technology as Knowledge)*
Planning for Practice *(Technology as Activity)*	Characteristics of Technological Outcome *(Technology as Artefact)*	Technological Products *(Technology as Knowledge)*
Outcome Development and Evaluation *(Technology as Activity)*		Technological Systems *(Technology as Knowledge)*

The 2007 technology curriculum identifies five technological areas that students should experience during the six years of their primary schooling. These areas include food technology, structural technology, control, biotechnology and information and communication technology. This study of chocolate and chocolate-making is situated within the area of food technology. The knowledge base, which is specific to this and other technological areas within this curriculum, is recognised as vital to students' knowledge and skill development, and graphics and other forms of visual representation are acknowledged as important tools for both the exploration and communication of design ideas. The influence of culture, ethics, politics and economics, as well the impact of environmental issues of the day, are also acknowledged in the introductory paragraphs of the curriculum and opportunities for these to be integrated and developed through students' technological practice are identified in the Nature of Technology strand.

Technology education in New Zealand, and what it means in the context of this study, is guided firstly by the aims of the New Zealand technology curriculum and specifically the Indicators of Progression for Level One, which are located on the Ministry of Education website, Te Kite Ipurangi (Ministry of Education, 2010a). The sections relevant to the teaching and learning of five-year-old students are described in the next section.

2.3.5 The expectations of five-year-old students (Year 0/1) participating in Technology Education

This section of the chapter looks at the guidance provided by the New Zealand technology curriculum (Ministry of Education, 2007a) for teaching students working at Level 1, typically students in their first three years at school. It also describes what can reasonably be expected from the new entrant five-year-old students who are in the first few months of schooling.

Emerging from an extensive curriculum review project during 2002, a revision of the technology curriculum was undertaken as part of a completely revised New Zealand Curriculum in 2007 (Ministry of Education, 2007a). As shown in Table 2.3, the new curriculum has three strands: technological practice, technological knowledge and the nature of technology. *Technological practice* includes students studying the practice of others and gaining expert advice before planning and carrying out their own practice or product development. The *technological knowledge* strand includes components of knowledge that are generic to all technological areas and contexts, for example, the performance properties of materials, the make-up of technological systems and the use of functional modelling. The *nature of technology* strand aims to provide an "opportunity for students to develop a philosophical understanding of technology, including how it is different from other domains of human activity" (Compton, Dinning, & Keith, 2007, p. 12).

These three over-lapping strands work together to describe students' overall technological literacy, that is, the development of knowledge and skills relating to the principles and processes of technology, the ability to select appropriate materials and design solutions, and understanding technology as a human endeavour and a domain in its own right (Ministry of Education, 2007a).

Technology Education naturally draws knowledge and skills from other curriculum areas. In this study, with its focus on New Entrant students, the early childhood *Te Whaariki* curriculum and the English curriculum for Level 1 students, offer guidance in the formulation of the technology unit to be taught. It will typically have a strong oral language focus (Ministry of Education, 1995; Ministry of Education, 2007a).

Table 2.3 The Level One strands and achievement objectives for technology education in the New Zealand Curriculum

Level One: Strands and Achievement objectives		
Technological Practice	**Technological Knowledge**	**Nature of Technology**
Planning for practice *****_Outline a general plan to support the development of an outcome, identifying appropriate steps and resources_	***Technological modelling*** *****_Understanding that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes_	***Characteristics of technology*** *****_Understand that technology is purposeful intervention through design_
Brief development *****_Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available._	***Technological products*** *****_Understand that technological products are made from materials that have performance properties_	***Characteristics of technological outcome*** *****_Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature_
Outcome development and evaluation *****_Investigate a context to communicate potential outcomes. Evaluate these against attributes; select and develop an outcome in keeping with the identified attributes._	***Technological systems*** *****_Understand that technological systems have inputs, controlled transformations, and outputs._	

By ensuring students have the opportunity to increase the skill level and sophistication of their oral language, they are better positioned to engage with all areas of the curriculum, including technology education, and the tasks and opportunities that are offered. Five-year-old students are at an early stage of language development, and within a technology unit most activities will involve discussion, supported planning and investigations with limited expectations for independent reading and writing (Ministry of Education, 2009). The technology unit is usually situated in any one of the five technological areas – structural technology, control, food technology, information and communication technology or biotechnology – although there is some flexibility in terms of those that may have particular relevance to a region or within a community (Ministry of Education, 2007a). The duration of a technology unit is typically one to two weeks, with the expectation that within this period the students will: (i) develop an understanding of the technological problem to be solved and the intended user of their solution; (ii) create a plan with their teacher for developing an outcome; (iii) investigate the context and possible solutions for their outcome; (iv) and produce an outcome that is in keeping with the identified attributes of the product (Ministry of Education, 2010a).

The students will be guided in creating simple two-dimensional diagrams or three-dimensional models of their product, make decisions about the materials that will be required for their outcome, and be as actively involved in the construction process as is possible, understanding that products are made up of a number of components (Ministry of Education, 2010).

Access to technologists or ‘expert help’ during these early stages enables teachers to begin to address the guidance of the technology curriculum, which states that “quality outcomes result from thinking and practices that are informed, critical, and creative” (Ministry of Education, 2007). In this way, students are building on their prior knowledge and the understandings that they bring to the technology task.

Pedagogically, there are a number of challenges that teachers face when teaching technology education to five-year-old students, and these generally relate to the students’ early language development, their design capabilities and their limited understanding of the process required to complete a final outcome. Students’ language development is discussed further in section 2.4.3.3 but their design capabilities and understanding of process is briefly examined in this section.

It is recognised by a number of researchers investigating primary students’ technology that young students’ understanding of the purpose of the technology brief can be easily lost in the multitude of activities in a busy classroom programme (Benson & Raat, 1995; Milne, 2002; Moreland & Cowie, 2011). Moreland and Cowie (2011) discuss this in terms of maintaining a sense of continuity and connectedness when teaching technology to this younger age-group. These students are known to have difficulty recognising that each phase of their work is not an end-point in its own right but rather one step in a more extensive process. Their design drawings are a good example of this. Young students may either disregard their design drawings when constructing a final outcome, despite being prompted to do so, or take the drawings home to share with the family before completing their construction (Anning, 1994; Milne, 2002;

Rogers & Wallace, 2000). Similarly, Fleer (2000) noted that young students do not understand the purpose of design drawings, what information they should contain or how they should be constructed. Rogers and Wallace (2000) emphasise the need for students to understand the difference between drawings that explain, as in a plan, and drawings that depict, as in a piece of art work (Egan, 1995; Rogers & Wallace, 2000). It would seem that where students are able to conceptualise the difference between the two, the task of creating a design drawing is more likely to merge with the process of technological development and give it greater meaning and purpose.

Despite these types of strategy, there still remains a significant challenge for young students planning a three-dimensional structure using a conventional two-dimensional medium such as drawings or sketches. Whilst there is evidence that young children are aware of the three-dimensional nature of structures, they have difficulty expressing the image they have in their mind through their drawings

(Hope, 2009; Jolley, 2010).

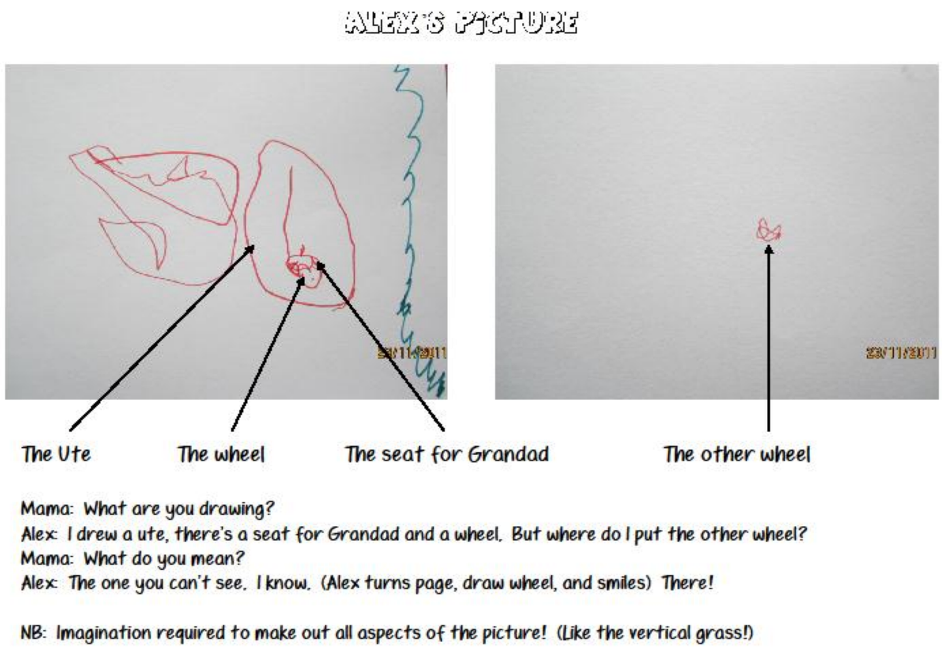


Figure 2.3 A pre-schooler's drawing showing her awareness of solid 3D

The figure 2.1, for example, demonstrates a pre-schooler's awareness of a solid structure and, only revealed through her conversation with her mother, her effort to express this in her drawing. The wheel, which was not evident from a frontal view of the vehicle, was drawn on the other side of the paper (A. Milne, personal communication, August 17, 2008).

The emphasis on design drawings, particularly with young students, has been challenged extensively (Mawson, 2007; Stables, 1997). The ability of young students to translate a three-dimensional structure into a two-dimensional drawing suggests higher-level thinking and abilities. In her early investigation into this issue when teaching young students technology, Anning (1994) notes:

> The ability to visualize objects in diagrammatic form and translate these images into line drawings, with all the attendant complexities of perspective, scale and overlap, is a particularly sophisticated, taught convention (1994, p. 179).

As a means of resolving this issue, Golomb (1989) suggests that students' design thinking can be enhanced if they are encouraged to communicate their design ideas by using a three-dimensional medium such as clay. This avoids the restrictions of managing a 2D medium in order to communicate a 3D structure, particularly as it relates to planning, positioning and alignment problems.

In general, the technological process of a five-year-old student is one that lies somewhere between the exploration goals of the *Te Whaariki* Early Childhood Curriculum in shown below Table 2.4 and the achievement objectives of the New Zealand Curriculum seen in Table 2.3. The students' practice will tend to focus on one solution and generally lack iteration or extensive review until the final solution is achieved (Milne, 2002). Design drawings can be encouraged, but left alone, students are most likely to experiment with materials in order to find a solution to their problem. Rogers and Wallace (2000) identified in their study that students made minimal use of any form of graphic representation before constructing models. In fact, where children were encouraged to express their ideas on paper prior to construction, they were keen to complete the task as quickly as possible so that they could move on to the making phase (Rogers & Wallace, 2000). Selecting an authentic, appealing and worthwhile context is key to student engagement (Mawson, 2006; Snape & Fox-Turnbull, 2013), remembering that during their early childhood experiences students are encouraged, through recognition of the value of spontaneous play, to "make their own decisions, chose their own materials and set their own problems" (Ministry of Education, 1996, p. 84).

Table 2.4 Strand 5 – Exploration described in the Te Whaariki Early Childhood Curriculum (Ministry of Education, 1996)

Te Whaariki **Early childhood Curriculum**
Strand 5 – Exploration
Children experience an environment where: • Their play is valued as meaningful learning and the importance of spontaneous play is recognised • They gain confidence in and control of their bodies • They learn strategies for active exploration, thinking and reasoning • They develop working theories for making sense of the natural, social, physical, and material words

2.3.5.1 Section summary

An overview of the philosophy of technology and the development of ideas that have formed and shaped the New Zealand curriculum has been presented in this section. The four categories identified by Mitcham (1996) have provided the framework for this discussion; technology as artefacts, technology as knowledge, technology as activity and technology as volition. These categories are widely accepted and form the basis of a number of scholarly publications including the work of de Vries, who presented a slightly broader definition of Mitcham's fourth category, describing it as a characteristic of humanity, rather than activity that is fundamental to being human. Research suggests that the concept of technology as artefacts is well understood, and is frequently the first understanding that students acquire. Technology as knowledge, based on Plato's description of knowledge as justified true belief, is central to students' technological practice. Developing technological knowledge is fundamental to students' progression in technology and it enables them to work towards achieving the overall aim of technology education, in which they develop "thinking and practices that are informed, critical and creative" (Ministry of Education, 2007a, p.32). Technology as activity is less well recognised (Mitcham, 1996) and may be viewed as practices associated with designing a product, making it and using and/or appreciating the product. "The user", in technological terms, is responsible for how the product is used, and a complex intertwining of product function, purpose, use and the ethics that surround each of these components adds to our understandings of technological activity. Again, authors of the New Zealand curriculum (2007) realise the importance of these concepts and signal their inclusion through both the 'values' component of the curriculum and in Strand C of the technology curriculum, the Nature of Technology. The final and closely related category of technology as a characteristic of being human is described by Mitcham (1996) as volition – the values that individuals, groups or societies attach to an artefact, and the resulting interest, motivation and acceptance that can be generated. Other views are expressed by the phenomenologist movement, the critical theorists, the pragmatist movement, and that group of philosophers who are referred to as reformational philosophers. The beliefs expressed through this section are worthy of consideration within this study because inevitably the core values of the students in this study, their parents and their families become a key part of the story being told.

The origins of technology are also investigated in this section, and relevant descriptions of the 2007 technology education curriculum are provided. It is clear that technology education provides an effective vehicle for exploring EOTC and this view is supported by the curriculum, which refers specifically to the importance of examining expert practice to inform students' own practice. The selection of appropriate strategies employed by teachers when implementing an EOTC experience will have a substantial effect on student engagement. The literature suggests that successful outcomes are most likely when teachers employ pedagogical practices that are age-appropriate to the thinking and capabilities of students, where the selection of a topic is relevant to their world and presents an authentic and interesting problem to solve.

2.4 The characteristics of five-year-old students' learning

2.4.1 Introduction

A final area of interest in this study is the characteristics of five-year-old students' learning. The central element of this section is their attainment of enduring understandings when participating in a learning experience outside the classroom.

Section 2.5.2 explores the influence of Piaget in educational research and specifically that which relates to the cognitive competence of the 4 – 7-year-old child. Section 2.5.3 turns our attention to Lev Vygotsky and the impact his research continues to have on current educational theories, particularly those relating to a cultural-historical or socio-historical view of child development. Section 2.5.4 builds on these two discussions and investigates the more recent information-processing theories beginning in the 1950s with the advent of the computer. The concept of a child's 'funds of knowledge' is introduced as this is believed to impact significantly on their engagement with classroom programmes. A final section looks closely at the New Zealand technology curriculum and the expectation for Level 1 students, with five-year-olds students registering at the beginning of this three-year phase of schooling.

2.4.2 The influence of Piaget in educational research

My initial forays into the field of five-year-old students' learning indicated that much of the research had its roots in the work of Jean Piaget (1896–1980), the Swiss theorist who was one of the first researchers to attempt to comprehensively describe the process of cognitive development in children (Krause, Bochner, & Duchesne, 2003). Aspects of Piaget's work have been the basis for much discussion and debate over the years but his work remains highly influential, particularly with regard to his technique of questioning children about how they make sense of their world (Krause et al., 2003).

2.4.2.1 Stages of cognitive development

Piaget began his career working in Alfred Binet's laboratory where he worked on intelligence testing, and this became a platform from which he pursued his interest in children's differing conceptions of phenomena across stages of development (Rogoff, 2003). The work of Piaget most familiar to many in the field of education is his 'stages of cognitive development'. He described these as the sensorimotor stage (birth to two years), the preoperational stage (two to six or seven years), the concrete operations stage (seven to 11 or 12 years), and the formal operations stage (from around 12 years onwards). There were two fundamental principles related to these stages; they were universal in that they applied to all children, and they were invariant, i.e. the order in which children progressed through these stages could not be varied (Krause, Bochner, Duchesne,

& McMaugh, 2010). In the latter phase of his career, when research methods changed and new interpretations of data emerged, Piaget noted that the ages at which the different stages were attained were variable and were influenced by the child's experiences and social environment (Piaget, 1954). Whilst many current researchers agree that the stage of development a child has reached is important, the association of an age is less so – what is sometimes referred to as the 'stage not age' concept (Krause, et al., 2010, p. 75). For example, there have been many demonstrations of cognitive competence in young children that have been observed to occur earlier than predicted (Siegler & Alibali, 2005). Qualitative research methods and a wider variety of research tools have shown conclusively that very young children are more able than was previously thought. For example, it has been shown that pre-school children are able to reason at higher levels than those indicated by Piaget, particularly when tasks are simplified or positioned within a familiar context (Kuhn & Franklin, 2006) – two themes of particular relevance, which reappear throughout this study. For example, some data has been gathered using non-verbal testing, similar to that of Piaget's original testing and other data has been collected within the family home or in an environment familiar to the child (Krause, et al., 2010).

2.4.2.2 The "pre-operational child"

Piaget's views of a child's cognitive competence at the preoperational stage, and particularly that of the four to seven-year-old child – the "intuitive sub-stage" (Piaget, 1977) – are of particular relevance to this study. Piaget's essays on conservation, spatial perspectives, logic and egocentrism are further commented on in this section.

Piaget maintained that the four to seven-year-old child is becoming less egocentric than younger siblings, and is beginning to relate to the needs, interests and preferences of other people but may be still unable to take the point of view of others. Siegler and Alibali (2005) agree in principle with this view but also believe that labelling young children as egocentric is a generalisation, which does not necessarily fit with the behaviour of both older and younger children. Children as young as two years can exhibit behaviours that indicate their concern for others, and older children can be exceptionally egocentric in their behaviour. For example, I have observed a child at two-and-a-half years giving an elderly relative one of his play-hut cushions because he knew she had injured her spine, whilst another at 12 years made the decision to spend the $5.00 change from his school lunch money despite knowing that his family were struggling financially. Krause et al. (2010) argue that “this development is not a matter of the absence and then the sudden presence of skills, as Piaget suggested, but a gradual acquisition of these abilities” (p. 76).

Piaget argued that the “intuitive sub-stage” child is more likely to make decisions based on intuition rather than logic and suggested that, whilst s(he) may develop representational skills of language, mental imaging and drawing to view the world, it is only from his/her own perspective and with a narrow focus, which causes him/her to ignore important information (Piaget, 1954). Furthermore, he suggests that although children operating within the “intuitive sub-stage” are able to represent static situations, they are unable to represent transformations, i.e., they are unable to solve problems relating to physically possible situations (Piaget, 1954). This view was observed in my own work (Milne, 2002), when New Entrant students interviewed in an earlier study were mostly unable to express how they might fix or improve the stand on a photo frame they had made. Whilst they could identify whether or not the frame functioned as they intended, they could not express how it might be modified in order to correct any malfunctions. If the stand on the back did not support the frame, the student was unable to suggest how the problem could be solved. As indicated in the previous paragraph, the gradual acquisition of these skills over time, through increased experience, greater knowledge of materials and their properties, and further developed language competencies, would enable a child to demonstrate greater proficiency in solving this problem (Krause, et al, 2010).

The preoperational child’s inability to understand the spatial perspectives experienced by others is another key issue resulting from Piaget’s research, which has particular relevance in this study. The learning spaces where EOTC sites are established are away from the classroom, some outdoors and others, such as museums and factories, are indoors. In an indoor setting, exhibits are usually set up so they can be viewed by the visitor from a number of different angles and positions. This may be problematic when a site education officer is presenting to young visitors and is unable to rotate exhibits or describe them from the same perspective or line of vision as the students are experiencing. Being aware of this limitation would enable presenters to compensate in some way – they may alternate positions, or invite students to come and inspect the exhibit more closely.

Another point worthy of mention in this section of the review is Piaget's research on conservation (number problems associated with changing shapes of water containers or changing length of a row of checkers) and centration (their understanding of time). Piaget argued that the preoperational child is unable to answer questions or solve problems that involve either of these concepts (Siegler & Alibali, 2005). Siegal (2008) takes a different view and questions the data-gathering techniques used at the time. He argues that using interview questions alone to determine children's knowledge is unreliable. He states that "children may in fact know more at an early age about reality and the phenomenal world of appearances – displaying a capacity for understanding that is liable to be overlooked" (Siegal, 2008, p. 6).

Research carried out prior to this by Gelman, Meck and Merkin (1986) concluded that, as long as young students work with only three or four objects at a time, they can solve problems relating to conservation. The issue is more about the complexity of the problems posed rather than the stage of the children's cognitive development. This view is supported by a study carried out in 2005 in which data from the 2000 New Zealand National Education Monitoring Project [NEMP] project was analysed. In this study, Year 4 and Year 8 primary school students were required to consider the best way to protect a strawberry garden from birds. They were shown a photo of the strawberry patch and a sketch of a frame and a cover that could be used to protect the strawberries. They were also provided with five different materials from which to choose the best cover. The results of this assessment showed conclusively that the younger students considered a fewer number of variables than their older counterparts when faced with solving a technology-related problem (Harlow, Jones, Milne, Moreland, & Forret, 2003). For example, many of the younger students were able to select a material that effectively hid the strawberries from the birds, but they did not always take into account the nutritional requirements of the plants – sunlight and water. It would seem, therefore, that in order to ensure a successful outcome when working with five-year-olds in technology education, the problem, need or opportunity with which they are presented should be simple, possibly involving only two or three attributes for their consideration.

In order for young children to progress through each developmental stage, Piaget identified the attainment of three critical processes – assimilation, the way in which incoming information is transformed so that it matches with existing understandings; accommodation, the way in which thinking is adapted to new experiences; and equilibrium, the way in which pieces of knowledge are melded into an accepted whole (Cohen, 2013). For example, a child's concept of animism and 'what is alive' changes and broadens as further information is presented and accepted. This is followed by a shift into a stage of disequilibrium until once again the child becomes satisfied with the new and enriched concept. Piaget further described these processes as the 'role of activity', asserting that children need to integrate new representations with their own general understanding in order to remember it (Siegler & Alibali, 2005). These ideas are central to young students' work not only inside the classroom but also beyond the four walls of the classroom. In terms of a constructivist view of learning, the teacher has an important role in acknowledging the knowledge and skills that students bring to the task, and effectively building on these when preparing them for an experience outside the classroom (D'Angelo, Touchman, & Clark, 2009) such as descried in this study.

2.4.3 The influence of Vygotsky and the socio-cultural and socio-historical view of learning

In the field of educational psychology, Lev Semanovich Vygotsky (1896 – 1934) is another theorist who has been hugely influential. Vygotsky was born into a Russian-Jewish family in Gomel, close to the Ukrainian border (Krause et al., 2003). In the mid-1920s, after working with special needs children for some years, he was invited to join the Institute of Psychology in Moscow, and together with Russian psychologists Alexander Luria and Alexei Leontiev developed a 'cultural-historical' or 'socio-historical' theory of child development (Miller, 1993). This work emerged from the period of time immediately after the Russian Revolution when Lenin, the Russian political activist who led the revolution, came to power. Lenin was influenced by the ideas and beliefs of Karl Marx and the work achieved in research institutions at the time, such as the Institute of Psychology in Moscow, were guided and shaped by these underlying ideals (Krause et al., 2010). The philosophy that thinking is influenced by the social environment became the foundational principle upon which Vygotsky's cultural-historical theory was based (Gredler & Shields, 2008). They argue that, "A corollary of the role of the social environment is that individuals raised in different cultural environments will differ in both the content of their thinking and the ways they think" (Gredler & Shields, 2008, p. 62).

These views have impacted strongly on the learning theories that have gained acceptance in today's education circles. The socio-cultural and socio-historical view of learning pervades most current research, and, in fact, provides the foundational evidence upon which many educational researchers build their new and ever-expanding theories (Krause et al., 2003).

2.4.3.1 Cognitive development

Vygotsky's theory of cognitive development is primarily a framework of social development, where the environment and the social interactions between children and adults establish the origins of all mental processes in the developing child (Cohen, 2013). This type of development was explained through the above mentioned 'sociocultural and socio-historical' view of learning, in which Vygotsky believed "that what is passed from adult to child includes aspects of current and past experiences, knowledge, attitudes and the beliefs and values of the child's social group, as represented by the carer" (Krause et al., 2003, p. 61). Vygotsky argued that the child's interaction with his or her environment would mould cognition in a culturally appropriate way, depending on the culture and history of the adults responsible for his or her care (Krause et al., 2003). When analysing the physical and cognitive development of a child, Vygotsky made a clear connection between these two factors and is quoted by Van der Veer and Valsiner (1994) as stating:

> The influence of environment on child development will, along with other types of influences, also have to be assessed by taking the degree of understanding, awareness and insight of what is going on in the environment into account (p. 343).

Thinking, as suggested above, can be considered as a social activity and Vygotsky maintained that ways of thinking and acting are learned by young children through their interaction with the adults and ‘more experienced others’ of their social group. Infants come equipped with what he describes as ‘lower mental functions’ (Vygotsky, 1978), which are biologically inherited. Through social interaction and the development of language, logic and abstract thinking, these evolve into ‘higher order mental functions’ (Vygotsky, 1978). An example of this was observed within my family. At five months old, Riley had been taught to click her tongue by her father – a game she only played with him despite the efforts of other family members. When he phoned home from work one day and asked to speak to her, she responded to his voice by smiling and clicking her tongue. To witness this at the time was surprising and it would be difficult to replicate that incident in another environment. Analysing this later on, it appeared that the learned behaviour of tongue clicking had been internalised and then reapplied in a more sophisticated manner. The baby’s reaction revealed that she could respond to the sound of her father’s voice and initiate their game, without requiring a visual connection with him. This demonstrated a refinement in her ability to communicate at a much younger age than earlier studies had suggested. This example was likely to be typical of other similar-aged babies, but could only be observed within the natural environment of her immediate family.

2.4.3.2 The zone of proximal development

Another notable feature of the work of Vygotsky is his concept of a ‘zone of proximal development’ common referred to as ZPD – the distance between what a child can do alone and what a s(he) can do with expert assistance (Vygotsky, 1978). A zone of proximal development consists of three key characteristics: i) the interaction between children and adults of unequal expertise; (ii) the internalisation (mental model) by the child of a transformed version of the communication; and (iii) the emerging ability of the child to think and act independently (Nuthall, 1997, 2007). Furthermore, and of relevance in this study, Nuthall argues that “our mental model allows us to anticipate and plan what we should do in order to solve problems, get what we want, and avoid dangers and mistakes” (p. 74).

2.4.3.3 Language development

Central to all development is the acquisition of language, both oral and written. The communities that each of us live in are primarily language-using communities, and the children born into these communities learn to use and share the dialect and accent of their particular social world (Whitehead, 2004). Vygotsky recognised language as a vital cultural tool and the medium through which most other mental processes developed (Bodrova, 2003). Krause et al. (2010) interpret this as "language beginning to serve an intellectual function, as a tool for problem-solving and self-regulation" (p. 85). Though language acquisition initially has a social function and allows very young children to interact with others, it develops into a thinking tool, and through the use of what Vygotsky describes as private speech, they begin to analyse their surroundings, make decisions and sometimes change previously made plans Krause et al. (2010).

Vygotsky recognised that the make-up and influence of a child's social world on their language development was significant. His investigations into the language development of profoundly deaf children, and comparative studies of children who were raised in care, led him to believe that on-going, individual interaction with an adult or carer had a discernible impact on the sophistication of language development. Vygotsky argued that the child who is excluded from "any interactions between the rudimentary and the ideal form" will result in the child's development becoming disrupted (Van der Veer & Valsiner, 1994, p. 351). More recently, research into language and literacy has highlighted that the language competence of the adults in a child's family, as well as the language skills of their peers, will impact on a child's language development (Connor & Morrison, 2012; Wright, 2012). Children in classrooms with peers whose language skills were more developed, showed substantial gains in their language development, whereas those children whose peers had less sophisticated language, tended to show little improvement (Connor & Morrison, 2012). It would appear, therefore, that the responsibility to address these disparities naturally passes to the Early Childhood Centres and schools that children encounter once they begin formal schooling.

Wright (2012) draws our attention to three current theories, which not only connect vocabulary and comprehension, but also attempt to explain the rationale behind the links. The 'aptitude hypothesis' argues for vocabulary being a measure for general aptitude, the 'instrumentalist hypothesis' states that the greater the vocabulary, the better a child comprehends conversations and text, and the 'knowledge hypothesis' argues that vocabulary knowledge equates to conceptual knowledge, i.e. "a child who scores well on a vocabulary test has high general knowledge" (p. 148). Despite the obvious variation between the three theories, the importance of a child's oral language competence to their long-term literacy development and their store of concepts about the world around them is clearly evident. Vygotsky identified two levels of concept development, which he referred to as 'everyday concepts' and 'academic concepts' (Gredler & Shields, 2008). His notion of 'academic concepts' for a child were those introduced through classroom instruction, is able to verbally define and examine, but may not be able to apply. The example of learning another language is used to explain this further – the learning occurs with clear intent, and the child is encouraged to link new concepts to existing understandings in a systematic and logical manner. The development of Vygostky's academic concepts shows a notable absence of concrete experiences (Gredler & Shields, 2008) relying on verbal instruction and abstract, higher order thinking. However, the underlying beliefs can be seen reflected in more recent work where scholars have continued to explore *how* to address the variations in student's vocabulary and knowledge in the early childhood years (Wright, 2012). The features of this are particularly relevant to this study, as students' language development was fundamental to their engagement in the chocolate-making context. Vocabulary teaching was embedded into the content-area instruction throughout the course of the technology unit.

In summarising some of the recent studies of vocabulary instruction Wright (2012) states, "this research emphasises the development of instruction that includes rich and explicit explanations of words, in-depth discussions of words in multiple contexts, and review and practice of words on many occasions" (p. 149). The New Zealand English curriculum incorporates many of these concepts. For example, in the Level One descriptions, reference is made to the use of oral language features to create meaning and effect, the use of a range of high-frequency, topic-specific and personal content words to create meaning, and the development of knowledge about word and sentence order to communicate meaning (Ministry of Education, 2007a).

2.4.4 The information processing theories

The neo-Piagetian theories of development along with other recent theories are referred to generically as information processing theories, and these have emerged primarily from the work of Piaget. These theories, which are summarised in Table 2.4, aimed at uniting Piaget's original work with current theory and practice, whilst other more recent theories such as psychometric theories, production-system theories, connectionist theories and evolutionary theories each with their own focus, overlap and together provide a range of insightful descriptions of young children's thinking. Siegler and Alibali (2005) discuss information processing theories in terms of a three-part framework – sensory memory, working memory (sometimes referred to as short-term memory) and long-term memory.

2.4.4.1 Sensory memory

Sensory memory is seen as the capacity to briefly retain large amounts of information, which is processed, selected and mostly discarded. This ability appears to increase with age as children's knowledge and experiences continue to multiply (Siegler & Alibali, 2005). Seifert (2006) supports this view but, rather than question children's ability to retain information, he has investigated how much they can retain at any one time. His results suggest that the older the child, the more adept they become at processing and synthesising information and dealing with simultaneous information.

Table 2.5 Information processing theories

Summary of Information Processing theories of Development (Siegler & Alibali, 2005)	
Neo-Piagetian	Based on Piaget's theories and focus on the biological-based growth of working memory, problem-solving strategies and goal setting
Psychometric	Theories aimed at clarifying the processes measured on tests of mental abilities
Production system	Theories intended to explain how changes in problem-solving occur
Connectionist theory	Theories are computer simulations of how thinking occurs and has a general resemblance to the working of the brain
Evolutionary theory (Cognitive evolution)	Theories based on an analogy between biological and cognitive evolution, e.g. Siegler's overlapping waves model

This view can be observed in practice when teachers of junior classes endeavour to organise their classrooms so that the environment is as free of unnecessary or distracting stimuli as possible. Distractions interfere with thinking in young children more than with older children (Seifert, 1993). Sigler and Alibali (2005) provide an example of young children's developing ability to cope with distractions in their capacity to play the game 'Simon Says'. In this game, the leader of the game asks children to copy his or her actions but only when the command is prefaced with "Simon says". If a child copies the action and this command has not been given, they are out of the game. The last person left playing the game is the winner. A pre-school child struggles to ignore the interfering information provided by the action of the leader whilst attending to their verbal command. For example, they will have difficulty ignoring a command such as "Put your hands on your hips", and play to the rules of the game by responding only when the action is presented as "Simon Says put your hands on your hips". A seven-year-old finds this much easier. Building on this idea further, it seems that tasks presented to a five-year-old that are multifaceted and require a combination of several skills as well as knowledge of the required procedure (for example tying shoelaces) need to be analysed and reduced to the most simple elements. With the reduced complexity, the task then requires young children to handle less information at any one time, and this may improve the likelihood of success (Seifert, 1993). An example of this that I observed involved a young father teaching his son how to tie shoe laces. He encouraged the boy to begin by creating bunny-ear shapes with his laces, and then to twist one ear around the other to make the first part of a knot. The child was able to visualise and complete these two steps, and with practice, add a third and final loop to finish the process. The New Entrant teacher employs this type of strategy on a daily basis as (s)he works to initiate young students into school life, constantly reducing complex tasks into smaller manageable pieces and increasing the students' independence and self-esteem.

2.4.4.2 Working memory

The second part of the information processing framework refers to working memory or short-term memory. This is best described as the combining of information from the sensory memory, with information from the long-term memory, and this in turn is transformed into a new form (Siegler & Alibali, 2005). For example, when a child first begins reading a book, Siegler and Alibali explain that “working memory combines the sensory information about the words on the page with long-term memory representations of the meanings of the words, and uses both sources of data to represent the meaning of the text as a whole” (2005, p. 69).

Recent theories consider working memory as two systems or paradigms, one concerned with language-based information or memory for prose, and the other with nonverbal, spatial, visual information or visuospatial memory (Baddeley, 2012). Perception and attention have a critical impact on working memory (Woolfolk, 1998) and the older a child is, the more information s(he) can retain, and the less he/she is distracted by events occurring in the immediate environment.

The effective functioning of working memory can be influenced in several ways. Seigler and Alibali (2005) identify three key effects that they contend show age-related improvements:

1. being able to recognise meaningful chunks
2. the rate of loss of information and rate of rehearsal
3. the ability to integrate information from verbal and spatial subsystems

Rehearsal in this context refers to the repetition of a word, phrase or chunk of information privately to yourself. Baddeley (2012) suggests that we can hold as much in working memory as we can rehearse in 1.5 seconds. Where there is a rapid rate of rehearsal, more material can be retained. The memorising of telephone numbers is a good example of this and explains why most people can generally remember up to a seven-digit number.

The concept of children rehearsing cognitive strategies in order to remember information has been the focus of extensive research since the late 1960’s (Seifert, 1993). It is a particularly useful concept to investigate when considering the effectiveness of the EOTC experience, and how enduring school-age students’ memory of this type of activity might be. Although it would appear that young children can be instructed in the use of effective strategies for remembering information, they tend not to use them spontaneously (Harnishfeger & Bjorklund, 1990). For example, if a group of older children are given a memory task in which they need to memorise a number of different images, they will engage in a variety of different strategies. They may categorise the images, they may study unfamiliar images longer, and they may vocally repeat the names of some images. Younger children are less successful. The strategies that they automatically employ are those that tend to be overly simple and prone to mistakes, particularly if they are interrupted or distracted (Seifert, 1993). Again the selection of the most effective strategy is believed to improve with age and, as stated by Bjorklund (2005), the benefits of using cognitive strategies do not seem to occur until a child is older and has practiced using them for a while – “a utilization deficiency” (Bjorklund, Miller, Coyle, & Slawinski, 1997). It would seem, therefore, that the New Entrant student may require significant support in order to recall the detail of a visit outside the classroom. The provision of activities and tasks by the teacher could help the student reinforce, consolidate and remember the learning goals of the experience, and in the long-term, apply the new knowledge that has been gained to other situations.

2.4.4.3 Long-term memory

Long-term memories are memories of events that occurred in the distant past (Cohen, 2013). Even very young children are able to recall experiences they had had some time ago and repeat pieces of information that somehow impacted upon their lives. This third section of the information processing framework is best described under three sub-headings: episodic knowledge – knowledge or memory of a significant event in a person’s life, for example, their first day at school; semantic knowledge – our knowledge of facts about the world, for example, ice is cold and fire is hot; and procedural knowledge – knowledge of the correct sequence in a process, how to do something, for example, riding a bike (Cohen, 2013; Siegler & Alibali, 2005).

Long-term memory in young school-age children is a key feature of this study. Typically, recalling what happened before the age of five or six is limited, and recalling what happened prior to three years of age generally results in recollections that tend to be indistinct and fragile (D. Cohen, 2013; Santrock, 2002). The term infantile amnesia can be used to refer to these very early autobiographical experiences, of which adults and older children generally have no recall at all (D. Cohen, 2013; Hudson & Nelson, 1986). Studying long-term memory in young children is complex because it is multifaceted and factors influencing the speed and completeness of memory may include how knowledge is represented in the memory, the child's knowledge base, their informal theories or beliefs, and interestingly, their parents' styles of interaction (Seifert, 1993). The child's knowledge base is a key facet of effective learning and relates to the background knowledge the child brings to the task and the familiarity children have with objects within that task. Drawing on the work of Piaget and his research into assimilation and accommodation, Woolfolk (1998) argues that the ability to "integrate new material with information that is already stored in long-term memory" is critical in constructing new understandings (p. 261). As can be observed with the very elderly or those suffering from dementia, young children's knowledge "exists in isolated pieces or pockets" and "these bits of knowledge are not always coordinated with each other" (Chi & Ceci, 1987). As children grow older, their ever-increasing experience and knowledge results in these 'bits' aligning and blending and becoming a more reliable base from which to draw. This view resonates with the neo-Piagetian view of theorists such as Fischer and Bidell (2006) who describe children's development not as a single pathway with stages to step through, but rather as a lattice of pathways linking together, which are influenced by gaining new skills and understandings and which together contribute to competence in a particular domain.

Very young children generally experience episodic memory and, as particular events are repeated, they develop generalised or semantic memories of each experience. By the time children reach school age they have developed internalised 'scripts' or schema – a design or a mental representation (Cohen, 2013), which enable the child to develop expectations of how certain events should unfold, for example, their bedtime routine, or how they should prepare for day-care. Seifert (1993) argues that these schema give rise to a child's burgeoning understanding of what makes 'the story of my life' – what a child can anticipate from the daily events in his/her life.

2.4.4.4 Creating enduring memories of EOTC

Memory of an EOTC experience would, in most cases, be viewed as an episodic event – a one-off focused visit linked to the current classroom programme. Whilst the work of Hudson (1983) asserts that young children can remember and recount many details of an unusual experience, for example, going to a circus, Siegler and Alibali (2005) argue that pre-schoolers' memories should be viewed as less reliable than those of older children. We could reasonably expect that the memories of a five-year-old would be more robust and more reliable. However, as Rogoff (2003) cautions, it is important not to give too much weight to specific age expectations because the age at which children begin to contribute to specific activities is strongly related to the support and constraints offered by their community.

To unpick this further, Siegler & Alibali (2005) describe memory in terms of three phases – encoding (which includes gist and verbatim memories), storage, and retrieval. As referred to previously, young children tend to encode lesser amounts of information based on what they notice as being important. Falk, Moussori and Coulson (1998) describe this as the 'lens' through which the experience is viewed, and which strongly influences what is noticed and remembered. Memories are considered to be a mixture of what is seen, what is known and what is inferred from an event. In addition, it is argued by Siegler and Alibali (2005) that young children store the gist of events they experience rather than verbatim representations and at times they fail to absorb important details altogether. When their understanding and inferences of an event may be incorrect, their retrieval of memory is less reliable and even more fragile This provides us with some valuable insights into the critical role that the classroom teacher plays and the pedagogical style employed when working with young students in an environment away from the classroom as discussed in Section 2.2.5.

The ensuing stages of storage and retrieval are naturally reliant on the information that has been encoded and these stages are not mutually exclusive. Storage of information and its later retrieval is influenced by how a child commits information to memory. Seifert (1993) gives the example of a research project in which children commit to memory the names of students in their class according to the position they were seated in the classroom. When asked to recall the students' names alphabetically the number of names students recalled was considerably less. For the effective retrieval of information therefore, it seems important to be aware of the child's organisation of stored memory. Siegler and

Alibali (2005) report on research in which the storage of information by children below the age of six was described as being relatively fragile and easily influenced by events that occur shortly after the event and before retrieval (Bruck & Ceci, 1999). Another research project, which investigated the use of evidence from young children as witnesses in court, reveals some interesting theories. Results from the work of Bruck and Ceci (1999) and Foley, Harris and Herman (1994) suggest that the retrieval of episodic memories by young children can be less accurate than those of older children because their memory is more susceptible to leading questions and suggestions. A reported example is of children being asked to imagine or draw events that did not actually occur and that they later reported as being real.

Young children may also be confused in an interview situation and be influenced by what they think the interviewer wants to hear or by the overly enthusiastic prompts of social workers, for example, or police who may be investigating child abuse (D. Cohen, 2013). They will try to give the answers they think the adult wants rather than sharing the ideas they hold, or they may, through prompting, remember incidents that never happened (Cohen, 2013). From this we can deduce that although children's memory can be manipulated and altered by outside influences, the strategies used in these situations can be advantageous when applied to enhancing memory recall in the classroom. For example, a common practice in the junior classroom is to ask children to draw a picture of a special event. Siegler and Alibali (2005) report on the work of Butler, Gross and Hayne (1995) in which five- and six-year-old students were asked to draw and report on a visit to the local fire station. These students were able to recall more detail about the visit than the students who were asked only to talk about the visit. This research concluded that drawing pictures of the event helped students think more deeply about the experience. In a similar project, Rovee-Collier (1995) identified a "time window" (p. 238), a period during which children's memories of an event will be strengthened if it is repeated, and particularly if this repetition occurs towards the end of the time window, when their memory is beginning to weaken. The duration of the time window is determined by when the child would forget the initial information (Siegler & Alibali, 2005).

A comparative research project carried out by Hudson and Nelson (1986) presents another valuable perspective that is relevant to this study. This project investigated repeated experiences and the impact these have on long-term memory and retrieval of information. These authors make a clear distinction between memory for specific episodes and general event memory. It was argued in their report that “as episodes of a similar kind are experienced over time, a general representation of the event type is built up and a precise specification of any particular episode becomes difficult to retrieve” (p. 253). For example, Seifert (2006) explains, “When the experience is a repeated one, such as a meal or bedtime routine, the particulars of specific occasions quickly become clouded with a general memory of the routine” (p. 12). Ulric Neisser, known as the ‘father of cognitive psychology’, coined the phrase repisodic memory when investigating the testimony of John Dean, former counsel to the USA President Richard Nixon, during a Senate Watergate Investigating Committee hearing (Neisser, 1981). Repisodic memory represents a repetitive series of events in which the recollections are not simply “averaged across the series of original events” (Neisser, 1997), but may contain some features that are exaggerated and others that may be repressed depending on what the person wants to remember.

The Hudson and Nelson study (1986) describes experiences that a group of three- and five-year-old children had at a holiday camp. The authors concluded that all participants were able to report the memories of events that were special and less frequent in great detail. In comparison, in the re-telling of events that were similar or had been repeated, information was generalised, contained little detail, and some elements were confused with others. It was argued that, where novel experiences are subsequently repeated, what is originally represented as a single occurrence may become irretrievable as a separate autobiographic memory, thus shifting a specific episode memory to general event memory (Hudson & Nelson, 1986; Neisser, 1997).

Over time, the accumulation of similar memories or experiences can be formulated into what Seifert (2006) describes as children’s informal theories or beliefs. These informal theories are the very broad concepts that the children believe implicitly and that they revise and restructure as they grow older (Seifert, 2006). These theories help them make sense of the world around them. For example, a young child whose first experience of animals is with a family cat will cause the child to initially categorise all animals as part of the same feline species. Over time and with new experiences of animal life, they tend to reconceptualise and begin to add to or substitute the mental categories they have developed, and in so doing, recognise the differences between other species such as dogs, mice, cows and sheep. Piaget describes a similar concept in his work, which he referred to as cognitive structures, 'schemes or schemas' – a mental image or cluster of related ideas used to organise existing knowledge and to make sense of new experiences (Krause et al., 2003; Nutbrown, 2011). These theories are similar to scientific theories and whilst the prior knowledge of children and adults is recognised as being essential to guide understanding and recall, they can be seen to constrain thinking and learning when the ideas are inaccurate (Flavell, Miller, & Miller, 2002). When presented with new evidence relating to an existing concept, young children will sometimes ignore the new evidence or accept a distorted version, so that it fits with their existing (sometimes incorrect) ideas.

The retrieval of memory is, therefore, multifaceted and there are many studies that describe the complexity of influencing factors, which either assist or impede memory. Knowing something of the informal theories that young students bring to their classroom experiences is valuable background knowledge for the classroom teacher when s(he) plans to take them on an experience away from the classroom, and cause an interruption to their usual routine.

2.4.5 Funds of Knowledge

A final section in this part of the chapter is the concept of 'funds of knowledge' – a term that has become influential within research associated with student learning. 'Funds of knowledge' is defined by Moll, Amanti, Neff and Gonzalez (1992) "to refer to the historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being" (p. 133). The underlying concepts of 'funds of knowledge' are not new and Vygotsky is reported as arguing that knowledge and skills passed from adult to child encompassed the "current and past experiences, knowledge, attitudes and the beliefs and values of the child's social group, as represented by the carer", (Krause et al., 2003). A clear connection can be made between these views and those of Gonzalez, Moll and Amanti (2009) and the theories expressed in their research publications.

Contemporary research into the development of young children's thinking and learning has highlighted the importance of the socio-cultural environment (Carr, 2000b; Siu & Lam, 2005). This includes contexts outside the classroom which, for many children, result in significant learning (Gutiérrez & Rogoff, 2003).

'Funds of knowledge' is a way of representing the cultural and cognitive resources contained by households and communities (Oughton, 2010). The concept of 'funds of knowledge' has been developed in response to the recognition that people are competent and have knowledge and life experiences (Fleer & Quinones, 2009). It also reflects a desire to move away from the deficit theorising associated with children going to school (Gonzalez et al., 2009) – the belief that low achievement in schools is due to a problem with students themselves, their lifestyle, their language, or their ways of learning. Gonzalez et al. (2009) argue that communities have a broad range of resources including knowledge that should be considered in classroom teaching. It highlights that for children coming to school, there is a wide range of people and practices that provide access to 'funds of knowledge' that shape their thinking. Andrews and Yee (2006) provide an example of this in their research into the ways two children, Nadia and Saqib, engage in activities and practices that inform their learning out of school. They highlight the diversity apparent through the ways individual families apply community practices. Nadia, for example, whose family was originally from Bangladesh, although very quiet and reluctant to offer her opinion in class, carried significant responsibility in the home, checking receipts from her father's business and translating text for her mother. Saqib, whose family were from India, displayed a strong sense of duty within his family, and a concern for those less fortunate than himself, but was regarded by his teacher as being lazy and inattentive in class. There appeared to be a significant difference in the way these children were viewed by their families and their teachers, and how they functioned in the home compared with their engagement in classroom activities (Andrews & Yee, 2006).

Graham Nuthall (1997) in a report to the New Zealand Ministry of Education, expressed his concerns about the apparent lack of connection between students' home life, their communities and their schooling. He cautions that:

> Curriculum knowledge and thinking have become divorced from their real origins and turned into commodities that have little meaning or significance in the lives of the students outside the school. Such knowledge as students do acquire in school lacks authenticity because of its artificial separation from the communities and sociocultural practices of which it was originally an integral part. Failure is the inevitable product of isolating students from legitimate participation in authentic communities of practice (1997, p. 56)

While there are potential difficulties in the identification and interpretation of these 'funds of knowledge' (Oughton, 2010) they provide an important way of understanding young children's technological knowledge, as much of their thinking will be shaped by their experiences outside school, and primarily at home. 'Funds of knowledge' are acquired from specific experiences children have outside the classroom. These may include visits to a museum, to a zoo, or to a factory, and may be with family or an organised school group. Research has shown that these experiences will often produce a lasting memory and that children can recall key aspects of the visit for a long time after the visit (Falk & Dierking, 1997; Rennie & Johnston, 2004).

As indicated earlier in this chapter, experiences outside the classroom contribute to children's learning in diverse ways. Of relevance to this study is research carried out by Mawson (2007) in which he identified several influences on learning in technology in the early years of school, with one of these being home influences. He noted that it is difficult to quantify such effects. However, the more recent research of Gonzalez et al. (2009) provides some guidance in their discussion about identifying and describing 'funds of knowledge'. They cited language as the most important influence on the development of 'funds of knowledge', not only that of the child but also the language competence of family members who, in effect, hold the key to a child's access to both family and cultural knowledge (Gonzalez et al., 2009). As discussed earlier in this chapter, when considering the work of Vygotsky, "the use of languages in both their oral and written forms, plays a crucial role in the formation and development of human intellectual capacities" (Gonzalez et al., 2009, p. 209).

2.4.6 Section summary

The investigation of literature in Section 2.4 provides a background upon which to develop the planned intervention framework for this study. The work of Piaget, Vygotsky and scholars of the information processing theories provide information about the cognitive development of five-year-old students, the role of language in their learning, and an insight into 'funds of knowledge' and how this may impact on student learning. A three part framework is presented, which explores how young children store and retrieve memories. This framework identifies three categories of memory – sensory, working, and long-term memory. The literature suggests that selected teaching strategies within each of these categories will enable the development of enduring memories of the students' EOTC experiences described in Chapter 4.

2.4.7 Chapter summary

The five-year-old participants in this study have attended school for between one to four months. They come from a diverse range of ethnicities and have a wide range of pre-school experiences and knowledge – some that is very limited, whilst others have benefitted from many rich and exciting opportunities to expand their understanding of the world around them. The main research question posed by this study is how the learning of five-year-old students in technology education is enhanced through relevant experiences outside the classroom; how to plan for the learning, the impact of a site visit on the learning, and the enduring understandings of five-year-old students resulting from these experiences?

In order to answer these questions, the chapter investigates literature in three discrete areas: Education outside the Classroom, Technology Education and the Characteristics of five-year-olds. The literature defines EOTC as experiences that link the classroom to the real world. Activities are expected to be hands-on, interactive, and to enrich the learning opportunities provided by the New Zealand curriculum. The concept of both informal and non-formal learning is also explored and this study concluded that 'free-choice learning' and 'perceived choice' learning offered the most accurate description of an EOTC experience. A number of publications attempted to identify the characteristics of effective EOTC and several drew attention to the management of a visit in three phases, before, during and after the experience. Little is known about the parent-helpers' role other than that of supervision. Whilst it has been noted that students benefit from small-group discussions, explanations of exhibits and assistance in gathering data during a visit, there appears to be a gap in the literature relating to how this level of support is best managed. We know that parents who have been trained to use an open-ended elaborative questioning technique are likely to enhance their children's recall of events (Reese & Newcombe, 2007).

This chapter also reviews the origins of technology, the development of the 2007 technology curriculum and specifically the expectations of students working at Level 1 of the curriculum. The early childhood *Te Whaariki* curriculum provides a useful comparison in this review, as the participants in the study have attended school for less than four months. Managing technological practice with five-year-old students requires care. Relevant literature stresses the importance of focusing on the development of students' oral language, employing teacher-led planning and research tasks, and carefully selecting teaching strategies that best suit the thinking and design capabilities of these young students. A final section on the characteristics of five-year-olds investigates the research of Piaget, Vygotsky and the information processing researchers who influence the pedagogical practices of classroom-teachers today. The cognitive development of the five to seven-year-old student is discussed, along with the encoding and retrieval of memories. The development of enduring memories of an EOTC experience is a critical element of this study because this enables students to transfer understandings of technological practice from one experience to another. The development of students' oral language also plays a key role in their learning.

A final area of interest in this review is the influence of 'funds of knowledge' on student learning. The classroom experiences of students are enhanced when a teacher is knowledgeable not only of individual students but of their families, their communities, and the values and cultural practices that govern their everyday lives. How a student's 'funds of knowledge' impact on their technological knowledge is uncertain and this was considered in this study.

In conclusion, this section of the review investigates the literature of technology education, education outside the classroom, and the characteristics of five-year-olds. It seems that little is known about the understandings and capabilities of the five-year-old students participating in a learning experience outside the classroom in order to inform their technological practice. This study aims to answer these questions. How this was approached is presented in the next chapter.

Chapter 3

Methodology

3.1 Introduction

This chapter explains the methodology and research methods that were chosen for this study. The research question directing this study asks how the learning of five-year-old students in technology education can be enhanced through experiences outside the classroom. This question is addressed through answering the following sub-questions:

1. How can a technology unit for five-year-old students, which incorporates an experience outside the classroom, be planned for?
2. How does a site visit contribute to the learning intentions of a technology unit for five-year-old students, which incorporates an experience outside the classroom?
3. What are the learning outcomes of a technology unit for five-year-olds that incorporates an experience outside the classroom?
4. What enduring understandings do five-year-old students retain from a technology unit, which incorporates an experience outside the classroom?

Section 3.2 begins by considering the nature of research and how this has evolved into procedures which enable educational researchers to investigate the practices of teachers in classrooms, across schools and within educational institutions. Section 3.3 outlines the research paradigm and theories which underpin this study. This is followed by a description of the qualitative case study methodology in section 3.4 which guided the collection and analysis of data. The overall research design is described in section 3.5 and includes details of the participants, the data gathering process, and its collation, analysis and coding. The final sections (3.6 and 3.7) focus on trustworthiness and issues of validity and reliability followed by an explanation and clarification of ethical considerations associated with this study. Section 3.8 provides a summary of the chapter.

It is anticipated that the findings and insights resulting from this study will contribute to the literature of Technology Education and Education Outside the classroom and progress the planning and pedagogical practices of technology educators when organising visits for young students outside the classroom.

3.2 Research – what is it?

“Begin at the beginning”, the King said very gravely, “and go on till you come to the end: then stop” (Gray, 1992, p. 92). This was very good advice when deliberating, with some uncertainty, about where to begin an account of the methodology of this research project. Revisiting the notion of research – clarifying what it is, and identifying the guiding principles that have influenced the practices of researchers over time, seemed an obvious place to start. Mutch (2013) described research as a purposeful, planned and systematic activity designed to answer questions, solve problems, illuminate situations and add to one’s own knowledge. She goes on to suggest that effective research requires a set of skills and an understanding of the process, including its strengths and limitations. Davidson and Tolich (1999) believe that research tends to employ a well-established format as it explores, describes or explains the phenomena under study, sometimes, as suggested by Anderson and Arsenault (1998), generalising and predicting further outcomes.

To assist us in gaining answers to the questions we have, we draw on the principles of experience, reasoning and research (Cohen, Manion and Morrison, 2007). Experience may be accumulated knowledge built up through the day to day encounters with events or people over a period of time. Reasoning can be classified into three major types: deductive, which advances hypothesis to implication; inductive, which progresses observation to implication; and inductive-deductive, which involves a route from observation to hypothesis to implication. Research, including educational research, requires the combination of experience and reasoning (Mouly, 1978).

3.2.1 Educational research

Educational research is one of many discipline-based research methodologies which, as the name suggests, refers to that which takes place in an educational setting but may also cover a broad range of topics. These may include the study of educational history or educational policy-making (Mutch, 2013). However, educational research is generally associated with investigations that relate to teaching and learning in the classroom, and can be undertaken by either individuals or by groups of teachers researching a topic of interest. It may involve an inquiry into teaching practice in a single classroom, across a school, a college or other educational institution (Menter, Elliot, Hulme, Lewin, & Lowden, 2011).

Historically, educational research has employed methods traditionally used in studying natural science, but over time this has invited vigorous debate. Shulman (1987) raised questions about the relevance of using methods within educational research that were developed in an entirely different field of study. With its focus broadly related to teaching and learning, Stake (1998) argued that educational research could be more accurately described as an applied social science or the study of human behaviour. Current practices see educational research influenced by a number of very different theories, and employing methods which can be quantitative, qualitative, or a mixture of both (Mutch, 2013). What distinguishes it, as argued by Mutch (2013), is its focus on “people, places, and process broadly related to teaching and learning – and its purpose – the improvement of teaching and learning systems and practices for the betterment of all concerned and society at large” (p. 24). Decisions regarding the category into which a researcher’s study will be best positioned are dependent on the research questions. These will determine the methodology and consequent methods of inquiry upon which the research project is based. Onwuegbuzie and Leech (2004) maintain that where this occurs, the best opportunity to obtain useful answers to the research questions is provided (p. 17).

3.2.2 Theoretical framework or paradigm

The methodology of research in this study refers to the theory about method – the approaches and the methods of inquiry that are used within the study and which enable the researcher to best answer the research questions. Bell (2010) asks three basic questions of researchers who are about to embark on a project – “What do I need to know and why?” “What is the best way to collect information?” “And when I have this information, what shall I do with the information” (p. 117). The response to these questions will drive the research process and dictate its design. Mutch (2013) highlights the connection between the researcher’s worldview, the focus of their research, and the structure and methods employed in carrying out that research. These three categories define the research framework and are frequently discussed in terms of three fundamental questions. The first asks the ontological question - what is the form and nature of reality (Guba & Lincoln, 1994) or the nature of the theory underpinning the research. This can be viewed through the eyes of an objectivist - an individual "who sees the world as something tangible and real" or a subjectivist - "someone who believes the world is constructed by individuals on the basis of their experiences or socially through their interactions" (Mutch, 2013, p. 62). Others describe this duality in terms of realism and relativism. The positioning of the researcher determines the outcome of the second question, which asks about the relationship between the knower and what can be known, or the epistemological question which determines the method to be employed in structuring the research. The third question is the methodological question, how can the inquirer go about finding out whatever he or she believes can be known (Punch, 2009), or how will the research data be collected and analysed? Guba and Lincoln (1994) confirm that this "must be fitted to a predetermined methodology" (p. 108) that is, the methods and techniques employed, depend on the theoretical framework of the researcher and the research questions.

The theoretical framework based on the ontological, epistemological and methodological sets of questions (A. Cohen et al., 2007b) can be further described in terms of two broad categories: the positivist or scientific paradigm which is associated with quantitative methods, and the interpretivist or constructivist paradigm (also called the naturalistic or hermeneutic paradigm) which is associated with qualitative methods (Punch, 2009, p. 18).

Positivism, originally associated with the nineteenth-century French philosopher, Auguste Comte, evolved from a belief that this new science of society could be investigated in the same manner as other sciences using the laws and theories of physiology or biology (Olroyd, 1986). Over time, these ideas have morphed into different approaches by philosophers and social scientists, one of which is known as logical positivism. This is commonly referred to as 'the scientific method', and which regards unverifiable statements to be meaningless – that is, a phenomenon cannot be proven unless verified through the collection of data and observable outcomes (G. Anderson & Arsenault, 1998, p. 4). This is an approach in which a researcher objectively seeks to discover general laws using scientific principles – "a dynamic process in which a researcher endeavours to gain understanding of a given phenomenon through controlled, systematic collection and analysis of data" (G. Anderson & Arsenault, 1998, p. 4). Anderson and Arsenault (1998) describe this method as one of self-correction in which "new evidence is constantly brought to bear and existing generalisations are constantly modified and corrected to accommodate [this] additional evidence" (p. 4).

Despite this, the application of positivist approaches to the study of human behaviour has proven to be less successful (A. Cohen & Manion, 1994) and particularly, in its application to educational research and the context of the classroom. The multi-dimensional nature of each situation, and the unexpected and uncontrollable events of the day demand approaches which are at odds with those employed by the positivist researcher. When Anderson and Arsenault (1998) stated that educational research is the systematic process of discovering how and why people in educational settings behave as they do, they also conjure up a picture of a natural setting, hectic with students and teachers carrying out their usual classroom activities; a picture, which accurately describes the milieu of this study, which is too complex and fragmented to be captured by positivist approaches.

Since the early 1950's criticism of positivism has emerged from several quarters, citing issues such as the reductionist and mechanistic view of nature (A. Cohen & Manion, 1994) encapsulated by Nesfield-Cookson (1987) who stated, "No matter how exact measurement may be, it can never give us an experience of life" (p. 23). The 1980's was a period of time referred to as the 'paradigm wars' when social scientists and philosophers challenged the quantitative methods of the positivist researcher and, at the same time, the qualitative methods of the interpretivist flourished. In support of qualitative research methods better meeting the needs of the educational researcher, Stake quoted the philosopher Wilhelm Dilthey's view that "science was not moving in the direction of helping humans understand themselves" (Stake, 1995, p. 35), and, similarly, Denzin and Lincoln (2003) claimed that quantitative research was "a science that silences too many voices" (p. 15) – a view which resonates well with this study. Claims and counter claims of context stripping, the exclusion of the meaning and purpose, the etic/emic dilemma, and other problems, were argued and continue to be argued (Guba & Lincoln, 1994). However, it would seem there has been a change of mood, a greater acceptance that debate over which method is best is no longer viewed as being helpful, that paradigms can in fact be complementary (Donmoyer, 2006). Shulman (1987) suggested some time ago that by pooling information, researchers working within different paradigms could provide a more complete picture of the phenomenon each had been studying.

In comparison, the interpretivist approach, in which this research is positioned, recognises that individuals construct their own social reality and set out to understand their interpretation of the world around them. Interpretivism is a set of beliefs which guides the action of the researcher. It reflects a viewpoint that the social world can only be understood by researchers who are familiar with, and are a part of the action which is being investigated (Donmoyer, 2006; Guba, 1990). The interpretive framework of inquiry is seen as a subjective undertaking. It is a means of dealing with the direct experience of people in specific contexts, and in this study, is a way of describing the multi-layered complexity of the classroom and the factory site selected for the students' EOTC experience (Cohen, Manion & Morrison, 2007). Furthermore, the interpretive paradigm is concerned with the individual research participant and sets out to gain an insight into their understanding of the world around them. The primary focus is on action that is intentional and consequential, followed by the analysis or interpretation of this action. The theory that emerges as a result of this action should, in general terms, be based only on the data generated by the research activity itself rather than on theory that may have preceded the research (A. Cohen & Manion, 1994).

The interpretive framework for educational research requires that the setting in which data is collected is seen in its natural state without intervention or manipulation by the researcher (Cohen, Manion & Morrison, 2007a). In this study it would mean observing the classroom as it would normally function, the usual hurly-burly of the classroom, with the environment, resources, participants and staff as they would be on any other school day. Altering this in any way would affect the validity of the result achieved.

The emergence of critical theory over the last 70 years is a theoretical tradition which was developed by a group of writers at the University of Frankfurt and influenced by the devastations of the First World War (Kincheloe & McLaren, 2003). Neuman (1994) describes this approach as one “that goes beyond surface illusions to uncover the real structures in the material world in order to help people change conditions and build a better world for themselves” (p. 74). It has its roots in the interpretive framework of inquiry and it is characterized by perspectives of neo-Marxism, feminism and materialism. More recently the work of Ladner, an African American sociologist in the early 1970’s raised issues of ‘value neutrality’ arguing that neither objectivity nor validity is, or should be, achieved in qualitative research (Greeson, 2006) - thus signalling the continuing frustration with current methodology and its inherent weaknesses in addressing issues of power and domination at all levels of inquiry.

It would be incorrect to suggest that there is any one unified approach to interpreting critical theory but it is reasonable to assert that contemporary advocates of critical theory view this as emancipatory in nature, where researchers deliberately set out to interrogate, engage with and act upon issues which constrain or exploit minority and marginalised groups (A. Cohen et al., 2007b; Kincheloe & McLaren, 2003). This fundamental concern for the power and privilege of groups and individuals within society generally centres on issues relating to race, class, gender, and sexuality (Kincheloe & Steinberg, 1997). Many critics have challenged the likelihood of minority or marginalised groups being effectively freed from their situation if they are not an integral part of the process (Kincheloe & McLaren, 2003) and the research process is not informed by ‘insider’ knowledge. Accordingly, there is intent within this approach that both researcher and participants together develop greater understandings of their situation, and are motivated to act (Guba & Lincoln, 1994). Employing the notion of reflexive practice, there is a ‘coming and going’, a sharing of descriptions, interpretations and analysis of data between the researcher and respondent, culminating in an agreed-to strategy for altering the situation and enacting it.

The influence of critical theory on educational research may be seen in practitioner research where educators study problems in their own classrooms or within their institutions often in the form of action research. The co-construction of knowledge which incorporates ‘insider’ knowledge, and is negotiated between the researcher and the researched, and where researcher understandings are shared and meanings checked, means the practice of a ‘reflective practitioner’ is revealed (Schon, 1983).

In conclusion, it is useful to return to the three questions posed by Bell (2010) which help shape an inquiry. As a researcher what did I need to know and why, what was the best way to collect information, and what would I do with the data that has been collected? The research question directing this study asks how the learning of five-year-old students in technology education can be enhanced through experiences outside the classroom. This, along with the experience and reasoning I brought to the study, determined the methodology. This was to be an investigation which takes place in the classroom and in a factory during the students’ site visit. It examines the direct experiences of the students, teachers and parent-helpers as they progress through a typical daily routine before embarking on a visit to the factory. There was no intention to solve a problem or to act upon issues which emerged, as in critical theory, and the hurly burly of the classroom was no place to attempt to manage the controlled and systematic collection of data of a positivist study. An interpretivist approach was therefore, best suited to the classroom and factory environment and would enable the researcher to gain a complete picture of the complexity of this dynamic setting.

3.3 Data types

The philosophical approach of much educational research, as mentioned in the previous section, has seen a shift in recent decades from a positivist to an interpretivist paradigm. There has been a move from looking at knowledge arising from nature and being objective, to knowledge arising from the human mind and being subjective. In turn this has pushed research methods from ‘scientific’ quantitative in the direction of ‘social’ qualitative (A. Cohen et al., 2007b).

All research requires interpretation (Stake, 2010) but it is not neutral and the worldview, prior knowledge, and understandings of the researcher about the field of study being investigated, as suggested earlier, impacts on both the approaches and the conclusions that are reached. Similarly, the purpose of the research dictates the type or category that should be employed, and most importantly, the nature of the data to be collected.

Whilst there are several types of research in educational settings, a key element of educational research is its use of empirical or observable data to answer research questions, that is, data which is based on or characterised by observation and experiment instead of, for example, data based on existing theory (Punch, 2009). An empirical study, such as this study, necessitates the collection of data from young students and their teachers, in both a classroom and a factory setting, and it is the type of data that can be collected, along with the practical outcome of the study, which shapes this inquiry.

Data that can be used in empirical research, fall into two broad categories: quantitative, or data that is recorded in the form of numbers or measurement; and qualitative, data not generally in the form of numbers but always descriptive (Punch, 2009, p. 3). Whilst quantitative data is useful for establishing evidence of a proposition or theory, and for gathering and analysing human and non-human data such as test results, graphs and statistical information, it is less useful in describing the multi-layered richness and complexity of the classroom. A qualitative approach was therefore employed in this study.

The classroom environment at any level is unpredictable, and individual components cannot accurately be viewed in isolation. For example, the ability of a new entrant student to answer a series of interview questions will be influenced by the environment in which they are being interviewed, the number of distractions in the immediate vicinity, whether they have eaten during the day, whether they are feeling safe, whether they are sufficiently clad, and the nature of their relationship with the interviewer. To carry out an effective interview the researcher requires knowledge of the students - their language competence, their interests, and something of the culture of the classroom. It also requires time dedicated to developing a researcher/student relationship, so that each participating student is able to confidently engage with the researcher and the tasks that are allocated. With this type of background knowledge and by employing a range of data collection methods that are presented over time, it is possible to address these issues and avoid some of the pitfalls which are often attributed to the data collection practices of the qualitative researcher.

3.4 Case study research

The design of this inquiry required the collection of empirical data within both the classroom and a factory environment. In order to identify the characteristics of a successful EOTC experience for the five-year-old students, an in-depth investigation into the physical and social environment of the classroom and the visitors' space of the factory was required. Based on the understandings presented in this chapter, employing a case study approach to investigate and document this inquiry appeared to be the most appropriate method.

Case studies are not limited to the domain of the qualitative researcher, and may in fact involve a combination of qualitative and quantitative data collection, depending on the type of data collected, the method employed by the researcher and the research questions. In this inquiry the focus is on the practice of the qualitative researcher who studies things in their natural setting, and attempts to make sense of, or to interpret phenomena (Denzin & Lincoln, 2003). The parameters of an inquiry can be described as a 'bounded system' – a system in which clear boundaries are drawn up to outline the study (A. Cohen, Manion, & Morrison, 2007a; Punch, 2009; Smith, 1978). Stake (1995) refers to the research of Smith (1978) who describes the case study as a specific, complex and functioning thing. It is unique in the story it tells and provides the reader with a structure in which they can find and begin to unravel their "own perplexities in the lives of others" (Stake, 1995, p. 7). For example, a classroom teacher struggling with the demands of assimilating new immigrant students into the class programme may find answers to her questions in a case study investigating a similar context.

It is unusual for a case study to be more than the modification of similar studies – generally one study will build on the work of another, refining and enhancing the understandings of the researcher and his/her audience. Anderson and Arsenault (1998) refer to these as generalisations – petite or grand generalisations depending on their nature and their educational significance.

The role of the case study researcher can assume a number of positions. Stake (1995) describes the role as that of a teacher, an evaluator, an advocate, a biographer or an interpreter. The stance taken in each of these roles is self-explanatory, but whichever is utilized, the researcher is responsible for telling a story - deciding what the story will be and selecting what of the story will be told. Stake (1995) asserts that “less will be reported than was learnt – what is necessary for an understanding of the case will be decided by the researcher” (p.86). This raises the issue of reliability as the conclusions that one researcher may come to could differ significantly from those reached by another researcher (G. Anderson & Arsenault, 1998). This is discussed further in Section 3.6.1. From a constructivist point of view, however, knowledge is socially constructed and it is the reader’s interpretation of the case which will also be significant in determining the understandings gleaned from a report. It is useful, therefore, to view the case study researcher as assisting readers in their construction of knowledge, invoking the privilege and the responsibility of interpretation (Stake, 1998b).

Yin (2009) describes three types of case study: the exploratory study which is a pilot study carried out prior to a larger study; a descriptive study which provides a narrative account of the study; and an explanatory study which tests or evaluates existing theories. Anderson and Arsenault (1998) view these categories differently and describe an intrinsic, instrumental and collective case study. The intrinsic study is the best description of this inquiry in which the researcher has a genuine interest in the case and desires a better understanding of the elements it contains. In comparison, the instrumental case study is one in which a case study is investigated in order to “provide insight into an issue or refinement of theory” (Stake, 1998b, p. 88). The third category, the collective study, could also apply to this study in which two classes, or cases, are investigated. A collective study, as the name implies, looks at a number of cases simultaneously “in order to inquire into the phenomenon, population, or general condition” (Stake, 1998a, p. 89). The pervading theme of all categories is that of non-intervention - gaining information through multiple qualitative methods which may include discrete observations, document analysis and where necessary, interviews. The outcome of these types of data collection is not readily predictable unless it takes the form of a critical case study, in which the researcher intends to take action based on the what is already known prior to data collection (Robson, 2002).

In most situations, although the researcher using a case study approach will anticipate and even know the issues, problems and relationships which will emerge as being important, they will learn that some of these have little significance, whilst others emerge as being of great consequence – it is an iterative process which may require the reframing of some of the initial research design (Atkins & Wallace, 2012; Stake, 1995). Yin (2009) builds on the notion of a case study being both a linear and an iterative process and sees this as a series of six key stages. These stages include planning, designing, preparing, collecting, analysing, and sharing or disseminating. Each of these are reflected in the organisational framework of this study.

The following section focusses on the collection of data and how this was analysed. Whilst a number of data collection methods could be used, in this study, it is achieved through the combination of student, parent and factory staff interviews, researcher observations and photographs, and document analysis. Understandably the involvement of the five-year-old participants in this study raises a number of issues which the researcher needs to be cognisant of. These include issues of interviewing and observing young children and the importance of the researcher-participant relationship within a naturalistic inquiry. The question of managing the environment in which the data collection occurs also needs consideration and, within this type of inquiry, to what extent this should occur. Each of these issues is discussed in sections 3.5.1, 3.5.2 and 3.5.3.

3.5 Methods

3.5.1 Interviews

Interviews were used as a primary method of data gathering from the students, teachers and the presenter at the factory site.

3.5.1.1 Interviewing students

The interview is a frequently used method in qualitative case study research. Asking questions and obtaining answers is, on the surface, a straightforward task, however, it offers a multitude of challenges when working with very young students. Never-the-less, it is an effective way of obtaining information and understanding human behaviour (Fontana & Frey, 1998). Where access to students may be complicated by classroom timetables, intervals and large numbers of students in confined areas, the interview is convenient and manageable when employed during school hours.

Cohen and Manion (1994) discuss the interview in a very broad sense and refer to it as “the transaction that takes place between seeking information on the part of one and supplying information on the part of the other” (p. 271). As a research tool, it enables the interviewer to understand more of what the respondent knows, likes or dislikes and what they think. Some researchers describe this as being able to “get inside the head of the respondent”, and explore the knowledge, information, values and beliefs of the interviewee (A. Cohen & Manion, 1994, p. 272). It has the capacity to test the researcher’s hypothesis and to suggest new ones, and can be used in conjunction with other research methods as a means of validating data that has already been gathered, or is intended to be gathered (A. Cohen et al., 2007b). An advantage over other data gathering methods is that the researcher can check participants’ understanding of the questions being asked during the interview, and can request further information if details emerge which are interest (Mutch, 2013).

The researcher has the option of several different forms and uses for the interview. These may include focus groups, casual conversations and semi-structured and unstructured interviews (Rubin & Rubin, 2012) - sometimes referred to as formal or informal interviews (Fontana & Frey, 1998). These can either take place face-to-face, as telephone interviews or through the use of the internet. Whereas the structured interview tends to follow a set of prepared questions, a semi-structured interview, whilst having a set of identified questions such as those composed for this study, will be followed in a more open-ended manner. An unstructured interview tends to establish broad themes, and whilst it may be initiated by a pre-set question, the discussion, as it unfolds, is driven as much by the participants as it is by the researcher.

The manner in which an interview is managed depends on the preferred interviewing style of the researcher, their personality, the nature of the interview, whether it involves discussing a controversial issue, and the purpose of the project. Rubin and Rubin (2012), agree that “what works is a style that makes the interviewee and the researcher feel comfortable and elicits the appropriate information” (p. 36).

The age group of the participating students in this inquiry limited the choice of method somewhat, and individual, face-to-face, semi-structured interviews were selected as providing the best opportunity for gathering research data. A responsive technique describes the preferred interview style used in this study. It is a style which is intended to build trust between the interviewer and the student, and one in which the tone of the interviewer is friendly and gentle and without confrontation (Rubin & Rubin, 2012). It also offers extensive flexibility in design, where questioning may vary between participants depending on what the interviewee raises during the interview. Ensuring an effective outcome through using this interview style depends on the students feeling safe and willing to participate, feeling free to express themselves honestly, and having a shared understanding of the language of the interview (Danby, Ewing, & Thorpe, 2011). Of greatest significance in this type of interview is the development of a mutual trust between the participant and the researcher (Kortesluoma, Hentinen, & Nikkonen, 2003).

Carr (2000a) carried out a study in which she explored strategies which facilitated greater child control of, and interest in, discussions with the researcher. In this study, which sought children’s perspectives on learning, she identified four key elements of interviewing young children which she considers “may have mitigated some of the traps of interviewing four-year-olds” (p.47). Based on the work of Tammivaara & Enright (1986), Carr (2000b) advocates having a specific topic or item to talk about which is understood by the child; providing tasks which, in the mind of the child are “natural and meaningful” activities and make sense (p. 47); and with the provision of open-ended questions, opportunities for the child to take control of the conversation (Krahenbuhl & Blades, 2006). These resonate well with the intended outcomes of this study. The context of making chocolates is one that most students are familiar with, and one they are likely to willingly participate in a conversation about their experiences of chocolate and chocolate-making. To discuss a planned visit to a chocolate-making factory that the students are to participate in is likely to be viewed as logical and to make sense to the five-year-old student. Similarly, reflecting on the visit afterwards would offer opportunities for them to discuss their attitudes and feelings towards the visit – what they enjoyed, what they learned and so on. The open-ended nature of the interview questions would also allow the student to initiate a change of direction in their discussion to aspects of the visit that attracted their interest and that they wish to discuss further. Their drawings and the photographs taken during the visit (see Chapter 4) would provide additional prompts, if required, to help them express their ideas and to progress their discussions.

Whilst Carr (2000a) has investigated strategies for successfully interviewing four-year-olds, Hatch (1990) has identified four common problems which may arise when interviewing young children. He describes these as the adult-child problem, the right-answer problem, the pre-operational thought problem and the self-as-social-object problem. In a normal researcher-interviewee relationship, the interviewee plays an active part in the research, understanding the role of the interviewee and knowingly imparting information to the researcher (Hatch, 1990). In nearly all cases, it is an adult who carries out the role of the researcher. The perceptions young children have of the adult-child relationship can prevent them from accepting the role of an informant. They see the adult as the source of power and control and as the usual source of information. The interview situation is therefore confusing to them and not always understood, particularly where the interviewer has not developed a rapport with the young participant. Students will often try to give the answers they think the adult requires, rather than sharing the ideas they hold (Carr, 2000a). It has also been observed that children believe that there are ‘correct’ answers to questions, and sometimes become involved in a type of guessing game during interviews (Hatch, 1990). This causes an information barrier, preventing children from considering and discussing their own beliefs. Compounding this problem is the assumption amongst some young children that the adult in the classroom must be a teacher and this can make it additionally challenging for the researcher to avoid a superior adult status in the interviewer/interviewee relationship (Hatch, 1990).

In reviewing the problems associated with using the interview as a source of research data with five-year-old students, the dependability of gathering this type of data may be questioned (see Section 3.7.1.4). However, the difficulties that have been raised may be overcome if consideration is given to the following suggestions. Hatch (1990) believes it is important to be aware of the developmental stage of the children being studied and to consider strategies that will alleviate some of the difficulties experienced in gathering interview data. In a practical sense this translates into making time to develop a rapport with the children, ensuring the language of questions is appropriate for the age-group, accepting all responses and indicating to the children that there is an expectation that they will provide answers. Furthermore, it is important to remember that these students will still be developing their linguistic and communicative competence, and talking with an interested and responsive adult will provide a valuable opportunity for them to share their ideas as well as be the provider of research data (Wood & Wood, 1983). The use of these types of strategies will assist in developing the informal, positive, researcher-child relationship essential in ensuring robust data and dependable outcomes (Hatch, 1990).

3.5.1.2 Interviewing teachers and factory staff

Many elements pertinent to interviewing young children also relate to interviewing adults – the key principles are primarily the same. For example, the teachers, factory staff member and parents who participated in research interviews and conversations, enacted the dual function of providing information as well as seeking information (A. Cohen & Manion, 1994). Whilst the semi-structured interviews with members of each of these groups sought to find answers to questions which related specifically to the research questions, the ensuing conversations also offered opportunities for participants to gain information. For example, in the course of discussions, they were able to clarify the purpose of the research, understand something of the nature of the five-year-old students participating in the visit, and also begin to appreciate the learning goals which framed the teaching unit.

3.5.2 Observations

Although interviews were the primary source of data in this inquiry, the use of observations as one method in the triangulation of data enabled background knowledge of the classroom environment to be gathered, an appreciation of the students and their behaviour to be developed, and as described by Merriam

(2001), reference points for subsequent interviews to be established. As a research method, observation is not the easiest option because of its multi-dimensional nature – at times verging on chaotic when the researcher attempts to conduct this in a junior classroom. It does, however, offer the potential to capture the most reliable and detailed information by gathering first-hand, authentic data in a natural environment (Bannister, Burman, Parker, Taylor, & Tindall, 1994) – data which has the potential to either verify or refute the results of the data collected using other qualitative methods.

As a result of these features, observation as a data gathering method was identified as being the most useful and practical method for both the New Entrant classroom and during a site visit to a chocolate factory. As researcher, I wanted to be free to observe and take notes, but also to be an accepted part of the environments that I shared with the students. There was no intention on my part to intervene at any point during classroom lessons or during the visit, or to disrupt the usual activity of the classroom (Merriam, 1998). On the other hand, it was important to be friendly and show an interest in the children's activities, to understand and be able to fit into the classroom routines, and to appreciate a little of the classroom culture. Classrooms invariably have their own set of practices and 'rules' and if these rules are not well understood, it is easy for a researcher to disrupt the usual flow of day-to-day routines. I was delivered a clear message during a visit to one of the research classrooms when I inadvertently sat on the 'Class Leader's' chair, thinking it had been positioned in the centre of the room for my benefit. Twenty-two pairs of eyes, and a firm word from the five-year-old whose seat I had taken, rapidly sent me off to locate my own chair.

My position as a researcher using observations as a method of data collection was technically one of a non-participant observer, and throughout most of the data collection this served my purposes well. However, with the uncertainty in any naturalistic inquiry, it was important to be aware of the effect that my presence may have on students, and to account for this during the analysis of data (Merriam, 1998).

Cohen, Manion and Morrison (2007) describe four observational categories that were originally identified by Morrison (1993). These categories are useful for gathering data and include observing the physical setting, the human setting (referring to the people being observed), the interactional setting, (the interactions that are taking place, and the programme setting (the resources, pedagogic styles, curricula and their organisation). Although not referred to extensively, these provided a practical reference point for planning observations in the classroom and in the factory.

Another layer for consideration is the degree of structure established by the researcher prior to executing this method of data collection. This study employed unstructured observation, as opposed to a prepared and structured observation. An unstructured observation is best described as a technique in which a researcher enters a situation, observes what is taking place before identifying the significance of the research. As stated by Cohen, Manion and Morrison (2000), it is a "hypothesis generating exercise rather than a hypothesis testing exercise" (p. 305). The researcher may have no preconceived idea of what is to be observed, no prepared charts or checklists, but rather records field-notes and writes these up in full immediately after the observation phase is complete (Bell & Gilbert, 1998; Merriam, 1998b). This method of gaining information has its greatest advantage in studying non-verbal behaviour, but it also allows the researcher to gather information as it occurs within the normal setting of the classroom. It gave me the opportunity to record exactly what happened in the relatively unstructured situation of the classroom. It allowed me to make visual comparisons between the various stages of the children's work, observe the interactions that took place between the students and the teacher, detect any tensions that were present, and observe and record any serendipitous developments – all of which may surface, merge and sometimes dissipate in the milieu of the junior classroom. In the factory setting, I was able to observe the interactions taking place between the parent-helpers and the students. Whilst I was able to note the physical detail of the factory setting, it was also possible to gain an impression of how effective the planning for the visit had been, and whether the guidance provided to the parent-helpers had been adequate. In gaining rich, multi-layered information about the everyday practice of the classroom and the impact of the visit on the students and their parents, this method was particularly valuable.

Cohen and Manion (1994) level criticism at this method of data gathering stating it can be, “subjective, biased, impressionistic, idiosyncratic and lacking in (the) precise quantifiable measures” (p. 110). It is also difficult to maintain control over the phenomena being observed (Bannister et al., 1994) and unexpected events such as an errant neighbourhood dog in the classroom, or a spilt drink in the cloak bay, can throw the classroom environment into chaos. As in any shared environment, there can be tensions, emotions or hidden agendas which exist within the classroom and which influence the performance and engagement of the students (Bannister et al., 1994). In a New Entrant room, for example, a parent who fails to arrive at lunchtime with food for their child will have implications for the physical and intellectual functioning of that child in the afternoon session. If a child has witnessed an angry scene at home before coming to school, their level of anxiety may be raised and their ability to concentrate may be impaired. Being able to record this level of detail goes some way to counter the criticism listed above.

3.5.3 Document analysis

The term ‘document’ in this context is a general term which refers to “an impression left on a physical object by a human being” (Duffy, 2010, p. 125). It usually involves printed documents, but can also include those accessed from an electronic source - items such as photographs, films or videos.

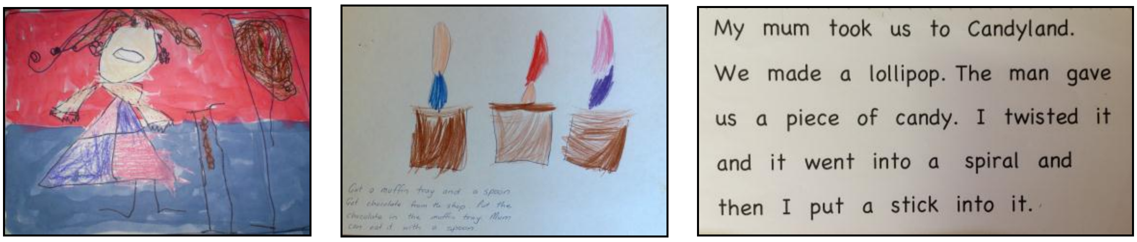


Figure 3.1 Three examples of student documents which were analysed

Document analysis in this study refers to the collection and analysis of student drawings and stories completed during the three phases of the technology unit and the visit to the chocolate factory (see Figure 3.1). Document analysis can be used to supplement information gathered by other methods such as interviews or observations, or, it can be the sole method of gaining research information (Duffy, 2010). There are two different types of document analysis, enumerative content analysis and ethnographic analysis. Enumerative analysis generally relates to the identification of word frequency, key words, and other fine grained approaches which focus on the make-up of text. Ethnographic content analysis, the type which relates most closely to this study, has a greater focus on identifying meaning within text or within an image (Grbich, 2013). For example, an important theme for analysis in this study was the students' understanding of process within product development, and the level of detail they are able to describe.

Regardless of the nature of the documents, the analysis employs a systematic coding system which enables the researcher to explore the text or images, and to identify the trends and patterns indicated by the selected themes for analysis (Grbich, 2013). In this study, the analysis of documents is primarily to cross-check information gathered through student interviews, but may also enable gaps to be filled where the information provided by the student at the time of interview may be incomplete. The themes that govern the analysis of this study emerged from the literature review but were confirmed, and sometimes discarded, as a result of the interview and observational data collected at the beginning of the teaching unit. These included themes of analysis from the LITE project i.e. students' conceptual, procedural, technical and societal knowledge; the three over-lapping contexts from the Contextual Model of learning i.e., the personal, the socio-cultural and the physical elements of an experience (Falk & Dierking, 2000); and the themes concerning the characteristics of five-year-old learners which include students' level of interest in the context, their transfer of ideas and their language development and language competency.

In summary, whilst this section has outlined the methods of data collection employed during this study, and how to overcome the challenges which a researcher faces studying five-year-old students, the next section (Section 3.6) provides further detail of the participants and how data collected during the interviews, observations and students documents were analysed.

3.6 The research design

This section outlines the design of the research. It describes the participants in the study, a chronological description of the research, and how this was developed over the three phases of the study. The section then outlines how data was collected and analysed.

3.6.1 Participants

This study took place in two New Zealand primary schools: Dayton (a pseudonym) is a large, urban, mid-range [5]decile school; and Oldpark is a six-teacher, high-decile, rural school on the outskirts of the city. The study focussed on the students in the New Entrant classes, with eight students in each class being identified to participate in three interviews and to provide data for analysis. The New Entrant class in the urban school consisted predominantly of boys with only three girls in the class of 17, and the rural school, interestingly the opposite – consisting mostly of girls with only five boys in the class of 22. The selection of students to participate in the research was specific only in regard to their willingness to participate in the interview, and where possible, to achieve a mix of ethnic and cultural backgrounds. It was hoped that a balance of boys and girls and ethnicities across the two classes could be achieved, as well as variation in the time since each student had started school – possibly ranging from very recently to four or five months at school (see Table 3.1 for details).

Practical reasons influenced the choice of schools for this study – both schools were within close proximity to the university, and both had an extensive working relationship with the Faculty of Education. The two New Entrant teachers, Rose and Hannah (pseudonyms), were well known to me; they both had over 20 years teaching experience, and were interested in taking part in the research. The factory staff consisted of Lance (real name) and two other staff members. Lance's role at the factory was primarily to lead the factory tours and when time allowed, he helped out on the factory floor. He was very knowledgeable about all phases of production in both the chocolate-making factory and the confectionary factory. The other two staff members were part of the production team and were occasionally called in to assist during presentations. These two staff members were not interviewed. The parent-helpers who accompanied the students on the

[5] A decile indicates the extent to which a school draws its students from low socio-economic communities. Decile 1 schools are the 10 percent of schools with the highest proportion of students from low socio-economic communities. Decile 10 schools are the 10 percent of schools with the lowest proportion of these students (Ministry of Education, 2014).

visit to Candyland consisted of a group of parents who volunteered to help supervise the students and to transport them to the factory. There was no selection process, as gaining parent help can be challenging in communities where both parents tend to be employed. Those parents who were transporting students were expected, however, to have a current drivers' licence. A separate invitation was offered to parents to help during the students' chocolate-making day which occurred at the end of the teaching unit. Similarly, the project was dependent on volunteers who were able to attend during the time assigned to this task.

Table.3.1 Details of the student participants in this study

School	Teacher	Student pseudonym	Ethnicity	Time at school	Class level
Dayton Primary School	Hannah	1. Ila	NZ European	5 months	First year at school referred to as New Entrant students
		2. Clarke	NZ European	3 months	
		3. Lyall	NZ European	4 months	
		4. Mana	Maori	4 months	
		5. Kayne	NZ European	5 months	
		6. Chris	NZ European	3 months	
		7. Billy	Chinese	4 months	
		8. Lewis	NZ European	5 months	
Oldpark Primary School	Rose	1. Dana	NZ European	1 month	
		2. Nick	NZ European	5 months	
		3. Lizzie	NZ European	6 months	
		4. Rosie	NZ European	2 months	
		5. Andrew	NZ European	5 months	
		6. Sean	NZ European	6 months	
		7. Kristy	NZ European	3 months	
		8. Olivia	NZ European	2 months	

3.6.2 Data collection

The collection of data comprised three phases: preparing for the visit to the chocolate factory; visiting the factory; and two interviews following up the visit one month and six months later. These phases are more fully described in Chapter 4. As part of each interview, a chocolate food item and one other non-food item, was presented to the students. The intention of this was to gain an impression of the students' knowledge of product development i.e. what were the steps required to make a product. The chocolate items were selected because of the obvious connection with the context of the students' study. Each consecutive item was marginally more complex in its structure than the previous one. For example, the chocolate frog was made entirely out of chocolate and cut into the shape of a frog. The Tiny Teddie was a bear shaped biscuit with one side coated in chocolate. The marshmallow Christmas tree was slightly more complex and consisted of a marshmallow filling which had been dipped in chocolate, and covered with 'hundreds and thousands' or sprinkles.

Item of technology	Before the visit	After the visit	Six months after the visit
Chocolate based item	 A chocolate frog	 A chocolate coated 'Tiny Teddie' biscuit	 A marshmallow filled chocolate Xmas tree
Other non-food item	 An 'academic' bear	 3D wooden dinosaur jigsaw	 A pair of toddlers' jandals

Figure 3.2 Images of the items used during interviews

The non-food items were selected for their simplicity and their appeal to the students. These are shown in Figure 3.2. The first item shown to the students was the 'academic' bear - a softly filled, 7cm high bear with a blue mortar board on its head. The 3D wooden jigsaw shown in the second interview was a multi-coloured dinosaur structure made up of five chunky pieces, 18cm long and fitted together allowing the dinosaur shape to stand. The toddlers' jandals shown to the students in the third interview were more complex and each one consisted of a multi-coloured foot piece, a plastic thong, and an elastic band across the back. As indicated in Figure 3.2, two items were introduced to the students at each of the three interviews.

3.6.2.1 Phase 1 of the data collection- preparation and factory visit

During the first phase of data collection two meetings were organised with the participating teachers Hannah and Rose, to outline the research project and to enable, as far as possible, the co-construction of the technology unit outline and the visit to the factory. These meetings were audio taped and the conversations summarised for further reference later in the project. A meeting was also held with the factory presenter Lance, during which an outline of the project was shared and an extended presentation time in the chocolate-making area was negotiated. The purpose of this meeting, however, was to share information and was not used as part of the data set.

Once the teaching unit had begun, a semi-structured interview was conducted with each student to gain an understanding of the expectations they had for the visit to the chocolate factory; how they felt about visiting the factory, the purpose of the visit, and what they expected to learn as a result of the visit. These interviews were audiotaped and were timetabled for approximately 15 to 20 minutes depending on the interest and focus of individual students. (See Appendix A for the interview questions.) Brief field notes were recorded during the interviews commenting on the students' engagement with the task and any other information which might be required as a back-up for the audiotape. In addition, an assessment of their knowledge of product development was included during the latter part of the interview, in which the students were asked to describe how they thought the 'academic' bear, and the chocolate-coated frog would be made. Informal discussions with the participating teachers and students were also carried out during this phase, as well as observations of the lessons designed to prepare the students for their visit. The lessons were audio-taped and field-notes were again recorded as back-up. Together these records provided a picture of the students' existing knowledge of technological practice, as well as providing base-line data which could be used to compare the results of the second and third interviews.

3.6.2.2 Phase 2 of the data collection

The second phase of data collection included interviews, observations, field notes and a photographic record of the students' progress through this second phase of the study. This included the visit to the factory, students' research and information gathering about their mothers' preferred type of chocolate, the design, and finally, the construction of their chocolate gift for Mothers' Day.

During the factory visit a photographic record and explanatory field notes were compiled which showed elements of the parent-helpers' and students' exploration of the factory shop. The chocolate-making demonstration led by Lance was also photographed, along with the students' practical experience of making a chocolate fish. The second presentation, also led by Lance, demonstrated the process of making boiled sweets and lollipops. This demonstration was also photographed, but not included in the data set of this study.

A semi-structured interview, which focussed on the visit to Candyland, was conducted with each of the students (see Appendix A for questions). They were questioned about their attitude towards the visit, what they saw and learnt during the visit and what they had hoped to find out during the visit. I was also interested to determine the students' perceptions of their learning while at the factory and whether it influenced how they made their chocolate gift. Towards the end of the interview, the students' understanding of product development was again examined and they were asked to describe how a Tiny Teddie biscuit and a 3D wooden jigsaw were made. This was intended to gauge the students' understanding of the product development they had observed at Candyland, and if they were able to transfer these understandings to a similar product – the Tiny Teddie biscuit, and then to a different type of product – the wooden dinosaur.

An interview was also conducted with the teachers, Rose and Hannah, at the conclusion of the teaching unit. These interviews were audio-recorded with the permission of the teachers and lasted approximately 30 minutes each. The interviews included questions about the teachers' attitude towards the visit, whether they may have had concerns about the visit and whether they felt adequately prepared. It also attempted to gain an understanding of their perceptions of the visit, the teaching and learning goals associated with the visit, and whether they felt these had been achieved. In addition, issues relating to the organisation of a visit, and strategies employed to effectively follow-up the visit were discussed. (See Appendix A for further details).

An informal and unplanned interview with two parents who attended the factory visit was also carried out at the conclusion of the teaching unit. These parents were particularly enthusiastic about the visit and the work their children were involved with and asked if they could also provide some feedback. The conversations focussed mainly on their own children's involvement in the visit, what they were interested in, and some of the questions they asked. With prompting they also provided impressions of the students' interest in the presentations, what they expressed an interest in afterwards, and which elements of the visit they thought were most appealing to the students.

To complete this phase of the data set, I recorded my observations and accompanying field notes of the lessons following the visit. At Dayton School, these consisted of the following:

- a review of the chocolate-making process they had observed at the factory;
- a discussion about how to find out what type of chocolate to choose for the gift, leading into the distribution of a simple questionnaire for the students to take home and complete with their mothers;
- a discussion about the questionnaires that the students' mothers had completed overnight, with a focus on the types of chocolate they preferred, and whether they liked fillings or plain chocolate;
- Story writing during which the students wrote about 'What Mum likes'
- A review of the chocolate-making process the students had witnessed at the factory
- An introduction to modelling and its purpose, followed by a practice session where the students made a chocolate shape out of play dough.
- A discussion with the students and the parent-helpers about the 'making day' and how they would prepare for this.

- In groups of three or four, the students worked with the parent-helpers to create their chosen design for their chocolate gift.

A similar process was followed by the teacher and students of Oldpark School (see the teaching unit in Appendix B).

Whilst these activities were being conducted, I kept an extensive photographic record of each stage of the process beginning with the students' review of the visit, the results of their research into their mother's preferred chocolate, the chosen designs for their chocolates and concluding with the 'making day' when the students made their chocolate gifts. Throughout this phase, samples of the students' drawings, stories and questionnaires were also collected.

3.6.2.3. Phase 3 of the data collection

The third phase of data collection involved a final interview with each of the participating students and photographs which captured something of the students' personalities and their enjoyment of their involvement in the research project. This final interview was conducted six months after the conclusion of the teaching unit with the intention of determining which elements of the visit and the experience of making the gift for Mothers' Day were retained as enduring memories. The interview questions that had been put to the students in the second interview were repeated, however, the items aimed at assessing their technological knowledge were changed. (See Appendix A for the interview questions). This time the students were given a marshmallow-filled chocolate Christmas tree and a pair of toddler's jandals to focus their descriptions of product development.

3.6.3 Data handling and analysis

"The processes of data analysis in qualitative research are complex," (Grbich, 2013, p. 1) and the views and choices made by the researcher naturally impact on the data that is collected, the design, methods and quality of data, and the manner in which findings are analysed and interpreted. These in turn, have a significant bearing on the research story that unfolds (Grbich, 2013). As described in Section 3.5, the data in this study was obtained through interviews, observations, and document analysis. This mix of methods was to enable a thorough cross-checking and triangulation of data to give the greatest possible credence to the interpretation of findings that emerged.

The steps of data analysis followed in this study are guided by the work of La Pelle (2004) and her investigation into the use of Microsoft Word tables for the coding and retrieval of interview data. She describes seven steps which include the following:

Step 1: Formatting interview data into tables

Step 2: Develop a theme codebook

Step 3: Add columns and code to capture face-sheet data

Step 4: Coding text rows with one or with multiple theme codes

Step 5: Sorting data tables and finding patterns

Step 6. & 7: Code validation/ correction and merging data tables (La Pelle, 2004).

All interviews were transcribed, and then each set of transcriptions was placed into a Microsoft Word table, with 1.5 spacing and 12 font for ease of management. A set of interviews contained within one table would include, for example, all 16 student interviews conducted before the visit to the chocolate factory. The two remaining sets included all student interviews conducted after the visit and similarly, the set consisting of student interviews obtained six months later.

The analysis of each set of student data necessitated the development of a theme codebook which would identify the key areas of interest within the research, the major themes that emerged from these and the sub-themes - a finer grained description of each theme (La Pelle, 2004). The categories of interest in this study that were identified prior to gathering data, were determined by the nature of the research questions and fell into three domains – technology education, education outside the classroom and the characteristics of five-year-olds. These categories gave focus to the review of literature, and highlighted a number of possible themes and sub-themes for structuring the student interviews and latterly for the analysis of interview scripts and drawings. Rubin and Rubin (2012) caution against relying too heavily on the literature as a source of coding, as there is a potential to miss "the insights in your data that are not in the literature" (p. 197).

In order to gain and preserve the richness of data, this study used a number of approaches. The major source of themes and sub-themes were identified through examining a representative sample of interviews, and noting those themes that "seemed to recur or that have some significance to the study" (La Pelle, 2004, p. 88). The analysis for technology education themes, however, was guided by the LITE (Learning in Technology Education) project (Jones & Moreland, 2004) in which four categories of knowledge had been identified - conceptual knowledge, procedural knowledge, technical knowledge and societal knowledge. These categories formed the basis of the New Zealand technology curriculum and were a valuable way of investigated students' technological knowledge. The analysis of EOTC was guided primarily by the Contextual Model of Learning (Falk & Dierking, 2000) which identified three over-lapping contexts, the personal, the socio-cultural, the physical and latterly, time. The themes selected for the analysis of the final area of interest, the characteristics of five-year-olds, emerged from the literature and from the data and included their interest and participation, their ability to transfer and apply new understandings, and the extent of their language development and their ability to communicate their ideas. Each area was allocated a numerical code, as were the associated themes and subthemes. Columns were added into the table to indicate the three levels of coding i.e. area of interest (1 - 3), theme (corresponding to the numerical code for the area, e.g. 1.1, 1.2, 1.3) and sub-themes, (also corresponding to the numerical code of the area and theme e.g. 1.1.1, 1.1.2, 1.1.3). Once completed, the task of placing the relevant numerical codes for the sub-themes alongside lines in the script was begun. (See Appendix B for further details).

In order to maintain the anonymity of participants, each student and teacher was given a pseudonym, and similarly, each of the schools was allocated a name i.e. Dayton School and Oldpark School. Once these details had been established, the first set of interviews was analysed. Patterns in student responses were identified, coding was checked for accuracy, a number of sub-themes were combined for greater efficiency of reporting, and others were discarded. For example, sub-themes such as "Unaware of the purpose of the visit", or "Unable to link to his/her own technological practice" were deemed unnecessary and sub-themes which were named but resulted in no actual data were discarded. Influencing factors that were raised by the interviewees, and which were not covered by the themes of analysis were noted on the table. For example, one student was distracted by the recent separation of his parents and this absorbed much of his attention during the interviews. Another student was unwell during the final interviews and again this impacted on his ability to participate fully in the interview. It was important to be aware of this and appreciate the causes for changes in student behaviours.

Microsoft Word provided the ability to search tables for specific themes, and a manual count of instances within a theme category was generally carried out. One sub-theme posed a greater challenge during analysis. Within the technology education area of interest, one sub-theme was the students' procedural knowledge. This required the students to describe how a product might be made in each of the three interviews, and their responses were analysed in terms of the number of steps in a process that they could identify. The complexity that resulted from these questions was as a result of students' limited knowledge of materials, material properties and the procedures such as cutting and joining materials which would normally be part of a development process. For these reasons, a decision was made to count all steps that the students could describe, regardless of the accuracy of them. At the point of analysis, further comment would be made and examples given in an attempt to present a full and accurate picture of the students' understandings.

The analysis of student interviews, their stories and their drawings (document analysis) was undertaken by using the themes described in Chapter 5. These include the themes of analysis utilised in the LITE project - students' conceptual, procedural, technical and societal knowledge, Falk and Dierking's Contextual Model of Learning (2000) which identified the overlapping contexts of the personal, the socio-cultural, the physical and latterly, time, and themes that related to the students' interest and participation in the study, their ability to transfer and apply new understandings, and the extent of their language development, and their ability to communicate their ideas. Data collected from interviews with Rose and Hannah, and to a lesser degree, the informal discussion with the two parent-helpers, were used to cross-check and cross-reference the findings from the student interviews. Field notes and the photographic record were another source of information which confirmed data collected during the student interviews but in addition, provided useful information about the role of the parent-helpers and evidence to indicate the extent to which they carried out the role that was asked of them. This data was analysed according to the themes described above and compared with results obtained from the student interviews and document analysis across each of the three phases of the intervention model.

3.7 Trustworthiness

This section discusses the criteria for judging trustworthiness within qualitative case study research (Guba and Lincoln, 1989). Trustworthiness refers to having clearly documented the research decisions, research design, data-gathering and data-analysis techniques and demonstrated an ethical approach (Mutch, 2013). In this study, the criteria for judging trustworthiness are examined through issues of credibility, comparability, transferability, confirmability and dependability.

3.7.1 Validity and reliability

The descriptions of this inquiry are composed primarily for teachers of junior primary students, along with educators, policy makers and other researchers involved in the provision of pre-service and in-service teacher education programmes. Being able to trust the research findings of the study is significant, and it is the responsibility of the researcher to produce valid and reliable information in an ethical manner (Merriam, 1998b). This means attending carefully to the key ideas of the study, ensuring the interviews are reliably and validly constructed, that data is accurately analysed and that the conclusions of the case study rest upon the data (Merriam, 1998). The following sections describe the criteria for judging the quality of research findings which, in positivist terms, Guba and Lincoln (1989) list as internal validity, external validity, reliability and objectivity. In qualitative research, internal validity is more a question of credibility, whilst external validity explores issues of transferability. Reliability considers issues of the dependability of data and its analysis, whilst objectivity refers mostly to the confirmability of the same.

3.7.1.1 Qualitative internal validity: An issue of credibility

Kvale (2007) argues that terms such as validity are regarded by some qualitative researchers as “being too laden with positivist conceptions from quantitative research” (p.122), hence the use of the descriptor ‘credibility’ in this context.

The merit of qualitative research can be measured by its accuracy, the selection of material to be included or excluded, and how it is organized and presented. Findings may be validated when a researcher methodically cross-checks data and findings with participants and colleagues in the same field (Stake, 2010) in order to confirm that what has been depicted is authentic, and that the constructions and interpretations of the writer are considered to be accurate (Toma, 2011). Collectively, this establishes the credibility of the researcher (G. Anderson & Arsenault, 1998) p. 77) and is considered by some to be the strength of qualitative work.

Creswell (2005) identified eight approaches for qualitative researchers to ensure that the story they tell, along with its analysis, is authentic. These approaches include triangulation, member checking, and using a ‘peer debriefer’ to question and cross-check the accuracy of the research. Triangulation is a common technique where more than one data source is used, either using multiple participants and collecting one type of data, or a single participant and collecting several sources of data (Lincoln & Guba, 1985). For example, in this inquiry on-going observations, student and parent interviews, and document analysis were all used to record phases of the research. Member checking, as the term suggests, is providing participants with transcripts, field notes or data analyses to confirm that they match with their own understanding of what happened (Mutch, 2013) in effect allowing the researcher to check their interpretation of events. It may also include further discussions about the conclusions that are reached (Toma, 2011, p. 272) and an opportunity to offer other perspectives. The participants in this inquiry were too young to read the transcripts so the task of checking these was given over to the classroom teacher. Both teachers, along with the children’s parents, were invited to check and feed back to me if there were any concerns. No parents took up this offer, however, the teachers were each provided with a full transcript of the interviews as well as a paper which outlined the main results of the research and the conclusions reached. These were met with an enthusiastic response and whilst some discussions took place, no changes were offered.

3.7.1.2 Qualitative external validity: An issue of transferability

The extent to which the findings of any one case study can be applied to other situations defines the notion of qualitative external validity. However, this becomes the source of much debate about the generalisability of findings and the limitations of this within qualitative research (A. Cohen et al., 2007b; Donmoyer, 1990). Anderson and Arsenault (1998) argue that “as generalisation is not a fundamental component of this type of research, qualitative researchers are not bothered by this limitation” (p.134) and Merriam (1998b) maintains that qualitative research, such as the case study, is selected because it offers an opportunity to understand a particular phenomenon in depth, not to find out “what is generally true of many” (p. 211) - it has its own procedures to ensuring validity. An additional layer of interest in this notion of transferability, however, is the engagement of the reader with the research findings. This will inevitably result in a plethora of ideas, assumptions and meanings for each reader, and will also be influenced by the pre-existing knowledge that they bring to the task (Stake, 1994, p. 95). This again raises an uncertainty about the generalisability of results but Stake (1994) maintains there are adequate “safeguards” for what he describes as “the hazardous passage from writer to reader” (p. 241). Stake refers to three strategies which he describes as thick, rich, descriptions of the research situation, a typicality or modal category which describes how typical the research is, and employing multi-site designs through using several sites, cases or situations, which maximize diversity in the phenomenon of interest. This inquiry incorporated two of these three strategies. The case study describing students' visit to the chocolate factory is indeed a rich and detailed description of the planning framework, of the classroom teaching before and after the factory visit and of the preparation and participation of students and parents in the visit (see Chapter 4). In addition, two relatively diverse classes of students took part in the research and the examples provided are expected to offer common ground for many readers and allow them to make comparisons with their own situations (Kvale, 2007; Merriam, 1998b), thus providing an opportunity for findings to be transferred from one situation to another.

3.7.1.3 Qualitative reliability: A question of dependability

Reliability in research refers to consistency in the measurement of data – the extent to which the replication of the same tests will provide similar results. Carrying out qualitative research, in which the researcher reports on her own observations of the social world and comments on the experiences of others (Denzin & Lincoln, 2008), means that the exact replication of this work is unlikely to occur. It is therefore more useful to consider the question of dependability rather than reliability.

The dependability of results in qualitative research is generally considered in terms of the research findings, the interpretation of these by the researcher and the data provided by the research participants. Whilst it is recognized that different researchers may have consistent views on the facts of any given situation, they may vary in their interpretation of what they mean – no one observer is likely to gain the same results as another (G. Anderson & Arsenault, 1998; Merriam, 1998a).

Anderson and Arsenault (1998) also warn of the dependability of participants' information, and suggest that relationships with the researcher, social position within the research group and particular personalities may all effect the researcher's interpretation of data. They maintain that in order to reconcile these issues, "in practice, researchers triangulate their data, develop levels of confidence in their informants, and treat their information accordingly" (G. Anderson & Arsenault, 1998, p. 138).

3.7.1.4 Qualitative objectivity: An issue of confirmability

The objectivity or impartiality of a study concerns the clarity with which the reader is able to ascertain for themselves the integrity of the data and its analysis. By providing adequate detail of raw data before analysis, the reader is able to create their own, sometimes alternative, interpretations of results and judge for themselves the potential influence of the research (Stake, 1998a; Wolcott, 1990). Furthermore, Guba and Lincoln (1989) suggest that in the case study it is important that, "data (constructions, assertions, facts and so on) can be tracked to their sources, and that the logic used to assemble the interpretations into structurally coherent and corroborating wholes is both explicit and implicit in the narrative of the study" (p. 243). In order to authenticate this, the provision of a detailed audit trail is the usual technique in a naturalistic study. Guba and Lincoln (1989) refer to these descriptions as a "confirmability audit" (p. 243) in which access to the data confirms in the mind of the reader the legitimacy and accuracy of the researcher's descriptions (see Figure 3.3). In this study, and as detailed by Anderson, (2002) it included electronic files of audio tapes, electronic and paper records of transcripts, field notes, notes of communications between participants and researcher, and reflective notes taken during the research process (Anderson, 2002).

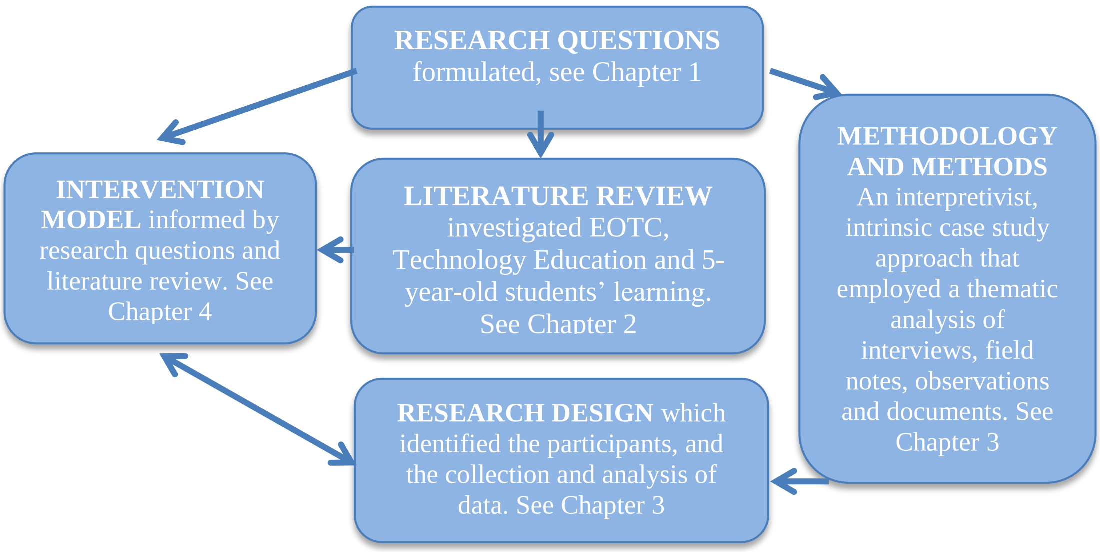


Figure 3.3 Audit trail

Additional factors which impact on the confirmability of a case study are the beliefs and personal experiences of the researcher. These will influence the worldview of the researcher and more specifically the interpretation of data so it is deemed important to share this with the reader (Mutch, 2013; Stake, 1995). Issues relating to the researcher's cultural background, personal bias, values and motives are acknowledged in Chapter 1 of this study and, where possible, reassurance given that the influence on the results of the inquiry is minimal.

3.7.2 Trustworthiness issues in interviews

Kvale (2007) advises that "if you want to know how people understand their world and their lives, why not talk with them" (p.1). The interview is the most commonly used data gathering method in naturalistic inquiry (Denzin & Lincoln, 2008), and as such has come under the scrutiny of a long line of researchers primarily concerned with issues of trustworthiness – specifically those relating to the validity and reliability of data collection and its interpretation.

The validity of the interview concerns the design of the study and whether questions accurately measure what they intend to measure (A. Cohen & Manion, 1994; Kvale, 2007). On the surface, this may appear to be so, however, it is challenging to the most astute researcher to decide whether the interviewee is overstating or understating responses and to what extent the resulting data is dependable. Comparing the interview instrument with another which is known to be valid, referred to as convergent validity (A. Cohen & Manion, 1994) is one way of validating results and in this study, however in this study, the triangulation of data proved to be an effective strategy. For example, in this study, the participants' descriptions of how chocolate was made in the factory during their interview can be compared to the drawings and stories of the same which they completed in class.

Interviewer bias is another issue to be factored into the design, transcription and analysis of the interview (Kvale, 2007). All researchers have bias (Stake, 2010) - it is a factor which permeates all aspects of data collection, and because of the nature of qualitative research, it is difficult to totally eliminate. The prevailing view is to recognise and constrain bias (Stake, 2010) and to minimise rather than remove (A. Cohen et al., 2000).

The cause of bias may emanate from the attitudes, opinions or understandings of both the interviewer and interviewee, and may be exacerbated by the subject matter of the questions (A. Cohen & Manion, 1994). Misunderstandings may result, whereby the interviewee wrongly interprets questions that have been asked and the interviewer draws incorrect conclusions from the responses received. Sometimes answers provided during an interview will vary, for example, it has been observed that in some cases where there is more than one interviewer, interviewees may give different responses to different researchers (Kvale, 2007). These issues all relate to the dependability and consistency of the data collected. It is the responsibility of the researcher to view the interview as a research method and along with the careful design of questions, well considered selection and matching of participants to researcher, some of the issues discussed may be alleviated (A. Cohen & Manion, 1994).

A final point worthy of mention relates to the method of recording interviews. Maxwell (1992) refers to the notion of descriptive validity and the challenge of including characteristics of the interviewee's voice and body language during interviews. Although a verbatim transcript may be recorded, omitting details normally provided by the inclusion of voice and body language could render the transcript less true, as tone, pitch and levels of stress also convey meaning. With increasing access to high quality recording devices, issues from the past in which a researcher may have relied on hand written notes and the inevitable 'slant' or interpretation of responses at the time, have diminished. The combination of digital recording devices, high quality cameras and video recordings enable researchers to collect data which relies less on interpretation and more on the multiple perspectives provided through voice recordings, images and (if appropriate) video footage. In this study it was decided to record all conversations with a digital recorder and to write field notes and keep a photographic record of each stage of the teaching unit – the classroom lessons, the visit, the research results and discussion and the construction of the final product. Video recording would have been valuable, but as a lone researcher in a New Entrant classroom some safety issues were raised along with the uncertainty of where my working space would be each visit. This availability of interview spaces is at a premium in most schools and so the arrangement was a loose one whereby use was made of whichever room happened to be available at the time of my visit. Spaces ranged from the Deputy Principal's office through to the Reading Recovery room, the staff room and at one time, an old converted dental clinic. In a very busy school with limited free spaces, to find a space at all was fortunate.

3.7.3 Summary of trustworthiness

The trustworthiness of a qualitative case study refers to the quality of goodness of the research process (Guba & Lincoln, 1989) and in this inquiry, has been examined through issues of credibility, comparability and transferability, confirmability and dependability. The goal of this type of inquiry is to portray a detailed description of a particular situation so that the reader is able to judge for themselves the relevance of the research, and the potential influence of the story presented on their own practice.

3.8 Ethical considerations

The ethical conduct of research depends on advanced planning and the anticipation of potential dangers which may intrude upon the privacy of participants, or offer a threat to their standing or reputation within their community (Stake, 2010). The relationship between researcher and participant in a research project should be one of mutual appreciation – each understanding and valuing the role being played out by the other (Stefkovich & O'Brien, 2004). This concept of 'mutuality' provides a firm foundation for ethical practice in educational research. The following section describes the ethical codes and principles required to gain approval for conducting research, including informed consent, privacy, anonymity and confidentiality. In addition, the differing 'world views' of the researcher and participant are considered, along with the costs/benefits ratio of the research. Together, these are an implicit part of a researcher's preparation for study and a fundamental part of the project design (Bannister et al., 1994).

3.8.1 Informed consent

Requesting the permission of participants before conducting research is common-sense and the underlying principle behind the notion of 'informed consent'. Wilkinson (2001) identifies two requirements in obtaining this – that the consent is voluntary and that it is informed. 'Voluntary' refers to the participant being free of any coercion or insistence, and 'informed' means the participant is given relevant information about the project with the expectation that the information is clearly understood. Cohen et al. (2007a) refer to the four elements in informed consent, as identified in the original work by Diener and Crandall (1978), these being competence, voluntarism, full information and comprehension. In educational research which involves school-aged children, it is vital that their level of competence in making decisions after being given relevant information is taken into consideration along with their ability to understand the aims and outcomes of the project. Young children are particularly vulnerable and require the guidance of a responsible adult such as a parent or carer to provide consent on their behalf (Atkins & Wallace, 2012).

Participants were provided with all relevant information about the research project, so they fully understood the nature of their involvement and the implications of that involvement. Informed consent was gained from the factory presenter and the two teachers prior to any interviews taking place, observations being recorded or the collection of documents. An assurance of anonymity was given and that pseudonyms would be used in reports of this research.

Informed consent was obtained from students' families. Adult family members provided informed consent on behalf of their child, but every effort was made to obtain informed consent from the students. If any family did not give consent, their child was not interviewed, observed or had their work collected. Participants were free to choose to take part, to make inquiries about any concerns they had with the procedures, and have them answered, and they had the right to withdraw at any stage in the research process. Information about the project was also provided to parents or care-givers of students involved as a matter of courtesy.

3.8.2 Privacy, anonymity and confidentiality

A second ethical principle relates to how information collected during the research project is used. A tension exists between protecting the individual's rights with regard to the information and the researcher's desire to publish and make known the results based on the information. In New Zealand, the Privacy Act of 1993 protects the right of privacy of participants, and the University of Waikato's ethical conduct regulations state that "the researcher must comply as far as possible with the spirit of the Privacy Act of 1993 and the Official Information Act of 1982" (University of Waikato, 2013, p. 115). There are two ways of meeting this 'right of privacy': the first relates to information given by participants which should in no way reveal their identity. Participants have the right to remain anonymous. The second is the promise of confidentiality. Similarly, the researcher should not make known to the public the identity of the participant - the researcher is the guarantor of confidentiality. The assurance of confidentiality on the part of the researcher is essential to ensure the trust of all involved in the research. Risks of participant identification can be minimised by ensuring information is not provided that will allow identification of the respondents. Thus information such as participant names, and addresses, and the name and location of the school, in which they teach and learn, will remain confidential. Participants and/or schools are identified using a pseudonym. Off the record or private communication was kept confidential. Participating teachers and factory staff were also informed of their need to maintain confidentiality to avoid inadvertently handing on information to "outsiders" that would allow identification of the school or other participants in the study.

3.8.3 Differing worldview of the researcher and participant

The researcher needs to take cognisance of the sets of beliefs the participants may have with regard to thinking, knowing and doing. Labaree (2003) raises the issue of cultural clash between the worldviews of the teacher and researcher. This can be extrapolated to the situation of researcher and participant. For example, when working with young children from immigrant families, this may emerge as a confusion about the purpose of questioning – why ask questions that you know the answers to? The relevance of these ideas rests with one of the two New Entrant classes taking part in this research. This class is made up of a diverse group of students and includes children who have recently emigrated from Somalia, China and Eastern Europe, as well as a mix of Māori and Pakeha students. It is necessary to be aware of the varying cultural beliefs, particularly in regard to photographing Muslim students, and ensure that if they are to take part in the research, that their parents or care-givers are fully informed of the nature of the research and the data that is to be gathered.

3.8.4 Cost/benefits ratio

Frankfort-Nachmias and Nachmias (1992) argue that consideration needs to be given to the potential harm participants may suffer as a result of their involvement in the research, as well as potential benefits the results may bring. Costs may include such things as affront to dignity, anxiety, embarrassment, and lowered self-esteem, whereas benefits could include advances in knowledge, researcher satisfaction in making a contribution, or monetary compensation for the researcher. There is a costs/benefits ratio to be considered and the researcher faces an ethical dilemma between the pursuit of truth and knowledge and the rights of the individual to remain free of harm (A. Cohen et al., 2007a). There is the potential for tension between the non-maleficence (do no harm) and beneficence (positive research outcome). As Wilkinson (2001) states, “One cannot justify imposing burdens on research subjects by simply appealing to gains to others or to the service of knowledge” (p. 15). In research in which participants are selected from two classes in two different schools, such as is described in this study, opportunities for comparison unavoidably arise. When the research is not set up as a comparative study, the researcher has the task of deciding what is fair, reasonable and respectful of the participants whilst ensuring a positive research outcome.

A final concern is the commitment of time and energy required of each participant. This needs to be communicated clearly and accurately from the outset of the research to avoid unnecessary pressure or anxiety being placed on the participants. Teachers, for example, need to understand when data will be collected, and the time frame over which this will occur so they are able to maintain their usual duties and responsibilities in the classroom and within the school community. Students, whilst possibly unable to anticipate the inconveniences they may suffer because of being withdrawn for interviews, need the protection of the researcher to ensure they are not being disadvantaged in any way. This might include ensuring interviews take place at times when students are assured of participating in special class events such as sports days, or class celebrations, where they can maintain usual daily routines such as morning tea and lunch breaks, and where they have usual access to bathroom facilities.

3.9 Chapter summary

This chapter presented the methodology employed in this study. It was a qualitative study working within an interpretivist paradigm. A case-study approach has been utilised to enable a rich and detailed description of the students’ technological practice to be presented as well as the engagement of the teachers and the parent-helpers. This chapter investigated the nature of research, and specifically that of educational research and how it applies to this study. The research design, including the data collection methods of interview, observation and document analysis that are used in the study, are described together with the themes selected for analysis. It also discussed issues of trustworthiness and how these have been considered and implemented to ensure the integrity of the study. The chapter concluded with an outline of the ethical considerations relevant to this study, specifically those which ensure the safety of the five-year-old participants.

The next chapter describes how the intervention incorporating the visit to the chocolate factory was planned and implemented.

Chapter 4
The intervention model

4.1 Introduction

Resulting from a perceived gap in the research literature, the intervention chapter describes a planning model for a learning experience outside the classroom for five-year-old students in technology education. As described in Chapter 3, this model was trialled using a case study approach in which the students participated in a visit to a confectionery and chocolate-making factory, known as Candyland, in order to examine the practice of experts before designing and making their own chocolate gift for Mothers' Day. Armed with a clear purpose the students were to gather information, explore existing products, and observe the process of making chocolates during the factory visit. This was to provide information and ideas that would enable them, on their return to school, to carry out simple market research, and model their design ideas before creating their chocolate gift for Mothers' Day.

Three main themes emerged from the literature review which influenced the formulation of the research questions and subsequently the intervention model: (i) the characteristics of Technology Education programmes that include EOTC and that support positive gains in student learning outcomes, (ii) contextualised learning beyond the classroom and its impact on student learning outcomes, and (iii) the long-term achievement and retention of student learning. In addition, the model draws together key elements of the Level 1 achievement objectives in the technology curriculum, and it considers the developmental needs of the five-year-old participants. The completed plan was to provide guidance for the research teachers, whilst maintaining the freedom to interpret and modify elements of the plan as they saw fit. In this chapter reference is made only to the intended plan and no comment is made on what actually transpired. Variations that occurred in the taught plan are referred to in Chapters 5 and 6.

Section 4.2 provides a brief background to the project, highlighting key features of Technology Education and Education Outside the Classroom as they apply to five-year-old students working within the context of making chocolates. This is followed by a description of the planning framework and its implementation. This

section is divided into three phases – preparing for the visit, organising learning experiences during the visit, and the planning and teaching that would occur directly after the visit. Within each of these phases the role of the teacher, the students, the parent-helpers and the factory workers are described as appropriate.

4.2 Background understandings

4.2.1 Technology education

As described in Chapter 2, Technology in *The New Zealand Curriculum*, which generally defines the practice of students in this project, is made up of three strands: technological practice, technological knowledge and the nature of technology (Ministry of Education, 2007a).

Table.4.1 The technology education achievement objectives Level 1 (MoE, 2007a)

Technological practice	Technological knowledge	Nature of Technology
Planning for practice Outline a general plan to support the development of an outcome, identifying appropriate steps and resources **Brief development** Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available **Outcome development and evaluation** Investigate a context to communicate potential outcomes. Evaluate these against the attributes; select and develop an outcome in keeping with the identified attributes	**Technological modelling** Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes **Technological products** Understand that technological products are made from materials that have performance properties **Technological systems** Understand that technological systems have inputs, controlled transformations, and outputs	**Characteristics of technology** Understand that technology is purposeful intervention through design **Characteristics of technological outcomes** Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature

During a technology unit, and over the time of a student's schooling, knowledge of these three strands come together to develop students' overall technological literacy, that is, the development of knowledge and skills relating to the principles and processes of technology, the ability to select appropriate materials and design solutions, and understanding technology as a human endeavour and a domain in its own right (Ministry of Education, 2007b). Advancing their technological literacy was the educational goal for the students participating in this planned merger of Level 1 technology education and EOTC that is described in this chapter. The achievement objectives from technology in *The New Zealand Curriculum* (2007) that guided this study are listed below in Figure 4.1.

4.2.2 Education outside the classroom

The inclusion of EOTC in the New Zealand curriculum is fundamental to this study. It is highly valued by the teaching community (Moreland et al., 2005) and it is supported by the Ministry of Education (Ministry of Education, 2011). The general philosophy as outlined on the TKI website is that EOTC programmes need to complement students' in-school learning and provide experiences that could not be made available within the usual school environment (Ministry of Education, 2011). Recommendations for EOTC of particular significance to this study advocate for activities that are relevant, hands-on, interactive, and that enhance and enrich the New Zealand school curriculum (Ministry of Education, 2011). In addition, learning goals should be clearly identified in teacher planning, and visits should be part of a more extensive classroom unit of work rather than a one-off activity. Preparation and follow-up to visits are vital in fulfilling the goals of all EOTC programmes (MoE, 2007).

The range of established EOTC sites, including those funded by the Ministry of Education as part of the LEOTC initiative, is reasonably broad, but when locating suitable sites for technology education, the options are limited. Of those sites that are available, there tends to be a focus on technological artefacts rather than the exploration of technological practice and the latter is a crucial part of this proposed study. I reasoned that rather than be constrained by the limitations of the existing government-funded sites, the teachers and I should look to other industry-based sites that provide access to the general public and demonstrate the 'expert practice' sought by the technology curriculum. As a result, Candyland, a chocolate and confectionery factory situated on the outskirts of the city where the schools are based, was selected.

4.2.3 Characteristics of five-year-olds

Chapter 2 discusses in some detail the characteristics of five-year-old students that may have a bearing on this study. Of particular relevance to the formulation of the intervention model is the impact that language development has on students' learning, their ability to recognise the inter-linking nature of the individual parts of their technological practice, the complexity of tasks that they can reasonably undertake, and the ephemeral nature of these students' encounters with technology in terms of how they tend to store and retrieve information.

It is well recognised that the acquisition of language is central to a child's development and, whilst it initially has a social function, it rapidly begins to serve an intellectual function as well (Krause et al., 2003). The introduction of context-specific language is an important element in the students' preparation for their visit to Candyland, and the on-going review and consolidation of new vocabulary associated with making chocolates was incorporated through each phase of the technology unit. This was fundamental to their engagement with the context and the learning that was to take place.

The task of seeking information to inform their practice of making a chocolate gift for Mothers' Day required the students to firstly understand the task they were to carry out, and with the support of the teacher and the parent-helpers, understand that each step in the process effectively informed their final outcome (Moreland & Cowie, 2011). It was not expected that these students would absorb all relevant information during their visit, or independently be able to draw on the knowledge they had accrued to make decisions about their final design of the chocolate gift. Accordingly, the intervention model included a phase of preparation of parent-helpers so they understood the teaching goals of the visit and the technology unit, as well as the significance of the students' research and design activities and how these were expected to influence their final outcome i.e. the chocolate gift for Mothers' Day (Schauble, Gleason, & Lehrer, 2002).

The manner in which five-year-old students store and retrieve information is very reliant on the 'lens' through which the experience is viewed (Falk et al., 1998) and this naturally impacts on what the student notices and remembers. One important factor is to provide an experience for these very young students that is focused and devoid of unnecessary distractions because this is known to interfere with their thinking (Seifert, 2006; Siegler & Alibali, 2005). The intervention model planned to provide such an experience. However, the choice of Candyland, with its two presentations of making chocolates as well as lollipops, did not entirely meet this criterion but was the best option available. Another factor was to understand how the students experienced the visit and exactly what they saw and how they responded. To address this, the visit was organised so the teacher would be free of supervision duties and would be able to experience the visit in the same way as the students (Seifert, 2006). This would enable her to draw on their recollections of the visit with greater ease, knowing which prompts and reminders to use in order to help retrieve their memories. A final point relates to the relatively fragile and easily influenced storage of information about an event by young children. Rovee-Collier (1995) identified a 'time window' during which children's memories of an event will be strengthened if it is repeated. The intervention model allocated tasks for students to carry out immediately after the visit that were aimed at consolidating and reinforcing the experiences they had had during the visit, and, as previously, these were to be revisited throughout the unit (Siegler & Alibali, 2005).

4.3 Description of the planning framework and implementation

This section describes the planning framework that was developed to guide the teaching and learning intervention of this study. An overview of the framework is shown in Figure 4.1. This framework is naturally informed by the characteristics of technology in *The New Zealand Curriculum* (Ministry of Education, 2007b) as well as literature relevant to this domain. It also draws on literature that examines students learning outside the classroom and particularly that which is specific to the needs of the five-year-old student.

Falk and Dierking's Contextual Model of Learning (Falk & Dierking, 2000) plays a key role, in which the over-lapping contexts of the personal, the socio-cultural and the physical dimensions of a visit outside the classroom are considered. Each of these categories is now considered through the three phases of the unit: preparation before the visit, organisation during the visit and development after the visit.

<table>
<tr><th rowspan="4">Research design framework</th><th></th><th colspan="5">Preparation before the visit</th><th colspan="2">Organisation during the visit</th><th colspan="5">Development after the visit</th><th>6 months after the visit</th></tr>
<tr><th>EOTC</th><td rowspan="2">Contact with two factories - Candyland selected for project.

Pre-visit to factory and meeting with liaison person and presenter

Teacher/ researcher planning and preparation for unit and visit</td><td rowspan="2">DATA 1a: Taped planning meetings with teachers.
DATA 1b: Photographs taken during factory pre-visit for creating a shared book for students</td><td>DATA 3: 1st student interview</td><td>Liaise with and prepare parents for their role in the visit</td><td>Prepare students for visit</td><td rowspan="2">Visit to factory including conversa -tion with presenter to check student under-standing during first class visit</td><td rowspan="2">Follow-up to factory visit</td><td>DATA 5: 2nd student interview</td><td colspan="3">Connect final three phases of students' technological practice with the knowledge gained during the factory visit and their final outcome</td><td rowspan="2">DATA 6: Teacher and parent interviews</td><td>DATA 8: 3rd student interview</td></tr>
<tr><th>Technology</th><td>DATA 2: Data collected of students prior knowledge and the concept development tasks</td><td>Liaise with and prepare parents for their role in the tech-nology tasks</td><td>Prepare students for tech-nology task</td><td>DATA 4: Data collected of students' visit to Candyland</td><td>Facilitate market research and design process</td><td>Facilitate chocolate -making process</td><td>Facilitate review and reflection of design and construc-tion process</td><td>DATA 7: Data collected of students design drawings, models, surveys</td></tr>
<tr><th>Week</th><td colspan="2">Weeks 1- 2</td><td>Week 3</td><td colspan="4">Week 4</td><td colspan="5">Week 5</td><td>6 months after</td></tr>
</table>

Figure 4.1 Research design framework

4.3.1 Preparation and planning before the visit

As outlined in the ethics statement in Chapter 3, my responsibility as the researcher was to firstly gain permission from the Boards of Trustees and the principals of the two selected schools to carry out my research in their New Entrant classrooms.

Once permission was confirmed, one New Entrant teacher in each of the selected schools was approached to ascertain whether they would interested in taking part in the research project. A letter of invitation was sent to these teachers outlining the key features of the research and highlighting the nature of their involvement. A follow-up meeting was planned to discuss logistics and answer queries. Once approval had been received from the teachers, informed consent was also sought from the care-givers of students in the teachers' classes. In addition, a group of eight students from each school was selected to participate in the research. In order to gather evidence of their developing technological knowledge, these students were to provide samples of their drawings, stories and models for analysis. In addition they were to be interviewed on three occasions – before the visit to Candyland, straight after the visit and six months after the visit. The selection of these students was to reflect the range of ethnicities, gender and ability within each class. However, it was also important that they were able to communicate in English and were sufficiently confident to express their ideas and opinions during each of the interviews. The parents of these students were sent an additional letter, which provided information about their child's involvement in this aspect of the research and a permission slip in order to gain their written approval for this collection of data (see Appendix A).

A similar process was planned for inviting the participation of staff members at Candyland. The manager was approached in writing with an introductory letter. A follow-up meeting was also offered to confirm details and answer questions if required (see Appendix A).

Once the project was underway, it was important to create a good working relationship between myself and the teachers, a relationship that established open communication and trust (Borko, 2004). In order to achieve this, I needed to value the knowledge and experience Rose and Hannah brought to the task and to facilitate a collaborative planning process that met the needs of the research project and the teachers. The outcome of the planning was intended to guide their practice rather than dictate it. The teaching style and individual strengths of the two teachers varied markedly, and the make-up of their classes would require them to interpret planning according to needs of the students in order to gain the best outcomes. I saw this model of co-construction and individual decision-making to be fundamental to the ensuing success of the project (Guskey, 2002; Huberman & Miles, 1984).

4.3.1.1 Planning with the teachers

Rose and Hannah (pseudonyms for the participating teachers) were invited to take part in the research in the latter part of the year preceding the beginning of the project. I knew the teachers professionally and was confident they would have the experience and expertise to effectively combine the technology unit with a learning experience outside the classroom. We met on two occasions. The agenda for these meetings was to introduce the research, to identify the key elements of EOTC and to frame up a context for a technology unit that would deliver teaching and learning opportunities and achieve the research goals. I was aware the teachers had a sound knowledge of the technology curriculum but had not attended professional development introducing the new 2007 curriculum (Ministry of Education, 2007b). They were both experienced in organising and managing their students on a variety of previous excursions, some recreational and some with a clear educational purpose, but neither had experienced using any of the Ministry of Education-funded LEOTC sites.

The strategy I elected to use to investigate teacher knowledge of EOTC was a simple Positive-Negative-Interesting (PNI) discussion chart in which the positive, negative and interesting elements of previous EOTC experiences were identified (see appendix B). The literature suggested that the following considerations needed to underpin the planning and preparation phase of the unit, and my goal was to develop a plan with the teachers into which we incorporated each of the following points drawn from the literature review:

- The selection of an experience outside the classroom that is novel, relevant, real world and age-appropriate for the students (D. Anderson, Thomas, et al., 2003; Wineman et al., 1996).

- Consideration of students' prior knowledge of making chocolate and building upon this before the visit (Rennie & Johnston, 2004; D'Angelo, Touchman & Clark)
- Planning to include focused pre-visit activities (Tofield et al., 2003)
- Selection of experiences from which students can gather information to inform their technology projects and that will help establish a 'need to know' focus (Jarvis & Pell, 2002; Lambert & Balderstone, 2000)
- Ensuring teachers have knowledge of the site and what it has to offer
- Communication with parent-helpers to share teaching and learning goals and to provide hand-outs that will identify individual responsibilities during the visit (Schauble et al., 2002)
- Communication with the site presenter to share the learning goals of the visit and to discuss the age-group and appropriate teaching level for the presentations during the visit
- Planning to ensure the visit is short, focused and free of unnecessary distractions (Falk & Balling, 2001)
- Pre-planning to ensure the visit includes hands-on exhibits and experiences (Rennie & Johnston, 2004)
- Investigation to ensure the availability of toilet facilities and refreshment areas for the children (Falk & Dierking, 2000)

My intention was to raise these issues if they were not raised by the teachers. Through this discussion, the nature and destination of previous visits that the teachers had undertaken would also be identified.

The PNI discussion exercise resulted in the teachers' completion of the following chart. Comparing this with the previous points drawn from the literature review, it is clear the teachers had a very sound knowledge of how best to organise an effective learning opportunity away from the classroom. What was absent at this point, were links through to the technology curriculum and using the visit to advance the students' knowledge of technological practice. It was necessary to further these discussions during the next phase of the meeting.

<table>
<tr><th colspan="3">Positive, Negative and Interesting [P.N.I.]

Considerations when planning a visit outside the classroom for five-year-old students</th></tr>
<tr><th>Positive</th><th>Negative</th><th>Interesting</th></tr>
<tr><td>• Hands-on / kinesthetic experiences
• Relevant to the teaching experiences/goals
• Relevant to the students
• Dynamic
• Within a meaningful context
• Of interest to the teacher
• Offers new experiences (new doors opened for the students)
• Independent work opportunities (of special interest to NE students who have moved from Pre-school to school)
• Challenging
• Exhibits clearly visible
• Include an element of making
• New language introduced prior to visit – children prepared
• Appropriate child/adult ratio achieved</td><td>• Too difficult in terms of both context and the manner in which it is presented
• Unclear rules or boundaries for behaviour in the site
• Distracted parents</td><td>• Prepare parents so that they understand their role during the visit
• Have clear expectations
• Prepare paper work in advance to address school and site safety obligations

Other

• Appropriate physical environment
• Physical limitations of young students during outings</td></tr>
</table>

Figure 4.2 PNI chart completed by the teachers Rose and Hannah

The next task was the selection of a need or opportunity that would be within the capabilities of five-year-old students and that would offer a worthwhile outcome when working with the technology curriculum. The choice of a site where students could access expert knowledge and practice, and which would inform the students’ technological practice was influential in the final selection of Candyland as an appropriate site to visit. Anderson et al. (2003) highlight the value of students experiencing an enjoyable visit during which there is an emotional or sensory connection with exhibits. In addition, arming the students with a ‘need to know’ agenda would provide them with a genuine research purpose for a visit (Jarvis & Pell, 2002). Whichever planning model was designed, there needed to be a very clear connection between the classroom programme, the technology task and the visit.

Being mindful of the specific needs of the five-year-old students, it was clear that an EOTC site that offered a single, focused learning experience would advantage these students (Falk & Balling, 2001) and could facilitate a memorable learning opportunity.

The teachers were united in their suggestion of a food technology unit to appeal to this younger age group. Several suggestions were discussed and eventually a decision was made to use Mothers' Day as a context for the unit, during which the students could investigate, design and then create a chocolate gift to give to their mothers. Two sites were suggested by the teachers where the students could find out how to make chocolates. A further investigation of both factories was carried out, including a site visit, and Candyland was eventually selected as the best option.

Candyland was already set up to accommodate tours and family visits and provided demonstrations of how confectionery and chocolates were made. The seating in each of the demonstration rooms provided visitors with a clear view of production with the associated heat, noise, and odours typical of a working factory. A hands-on activity was available during one of the presentations and a shop at the entrance offered an extensive display of all the products that were produced in the factory. This seemed to meet most of the elements identified above: the experience outside the classroom would be novel, relevant, real world and age-appropriate for the students; and there could be experiences from which students could gather information to inform their technology projects and that would help establish a 'need to know' focus.

The only real challenges to using this site for the teaching and learning purpose were the two presentations that were being offered during a visit – the first being a shorter chocolate-making presentation followed by the more extensive and interactive presentation, which demonstrated how to make boiled sweets and lollipops. To overcome this problem, it was decided to try and negotiate a more detailed chocolate-making presentation with the factory presenter during which the students would not only witness how the factory made some of their chocolates but could also make a small chocolate product to take home. Another problem was the timing of the presentations. The first demonstration was in the chocolate-making area and this was followed by the lollipop-making demonstration. This meant that when the students left the factory, the most recent experience would be making the lollipops and an immediate concern was this might impact on their memories of the chocolate-making. It was not possible to alter this sequence of activities because it would impact on the usual movement of visitors through the factory and cause disruption to groups who may be following behind. Our planning would need to accommodate this.

Whilst the teachers had recent experience in EOTC, I was aware they had no recent professional development in technology education to support them in interpreting the new curriculum (Ministry of Education, 2007a) and I anticipated having more input into this part of the planning. I was cognisant of the planning guidance provided on the Ministry of Education TKI website (Ministry of Education, 2009a) which outlines the expectations for a technology unit for Level 1 students. It states that students will: (i) develop an understanding of the technological problem to be solved and the intended user of their solution; (ii) create a plan with their teacher for developing an outcome; (iii) investigate the context and possible solutions for their outcome; (iv) produce an outcome that is in keeping with the identified attributes of the product. We would need to consider learning intentions that would meet the needs of the research and the context in which we were working, as well as the learning experiences of the students.

4.3.1.2 Site selection and planning discussions

Following these guidelines, the teachers and I co-constructed a teaching plan using the context of Mothers' Day and the design and construction of a chocolate gift. As mentioned previously, the teachers were free to interpret the plan according to the needs of their individual classes and to make minor changes where they saw fit. The planned teaching sequence for beginning the technology unit and preparing the students for the visit to Candyland can be seen in Figure 4.3 and the complete unit plan can be viewed in Appendix B.

	Teaching sequence for the technology unit
1.	Establish scenario - Mothers' Day coming up and chocolates often given as a gift.
2.	Establish problem e.g. How can we make chocolates that are safe to eat and that are (Mum's) favourite?
3.	Establish what students need to know in order to solve problem. This should lead into need to find an expert or visit an expert e.g. 'Candyland'.
4.	Establish what children would like to know about chocolates.
5.	Find out what children's existing knowledge is about the chocolate-making process – maybe draw a small sequence of pictures showing how they think chocolate might be made.
6.	Brainstorm what students know about the different types of chocolate, e.g. dark chocolate, milk chocolate, coloured chocolate, shapes and fillings. Chart these for reference later.
7.	Teach the chocolate-making process from the fruit of the cacao tree to the production of large blocks of sweetened chocolate for further use.
8.	Brainstorm/teach students about the different types of chocolate you can buy.
9.	Discuss how chocolates might be designed e.g. adding colour.
10.	Think about what they would like to make and how they might do that. This should lead into deciding what questions they will need to ask at Candyland.
11.	Explain the programme for the visit to students e.g. the chocolate-making presentation, the lollipop-making presentation, and the investigation in the shop of the different types, shapes and colours of chocolates.

Figure 4.3 Teaching sequence before the visit to Candyland

4.3.1.2 Preparing the students

Falk and Dierking's (2000) notion of 'perceived choice' and the students' voluntary participation in a 'need to know' (Lambert & Balderstone, 2000) investigation emerge at this point. It was deemed important to involve the students when first presenting the idea of a new unit. The reference to Mother's Day was to be raised by the teachers, and the students were to contribute ideas of how they might celebrate this. It was anticipated that they would be likely to identify chocolates as a gift that is often chosen for Mothers' Day and this would open the way for a discussion about making a chocolate gift themselves and finding out how to do this.

Understanding something of the students' prior knowledge about chocolate and chocolate-making was considered a useful measure from which to develop activities that would prepare students for their visit. The teaching plan suggested students draw a picture or a sequence of pictures early in the unit, which showed how they thought chocolate could be made. Information about their procedural knowledge, their technical knowledge and the vocabulary they had to support these concepts was expected to result from these activities.

The next step into this introductory phase of the technology unit was to gain a general impression of students' knowledge of the different types of chocolates that were available. For example, were they familiar with only milk chocolate or did their knowledge extend to dark chocolate and white chocolate? Were they familiar with the possibilities of creating coloured chocolates and adding fillings, and what did they know of moulding different shapes? These questions would be answered through class discussions and built upon by taste-testing a range of easily recognised chocolate types, such as those available in the local supermarket – working from the familiar to the less well understood concepts of chocolate and chocolate-making. Two simple texts had been located that described a little of the history of chocolate and how the flavour of chocolate was derived from the fruit of the cacao tree. These were intended to be shared with the students as part of their shared reading programme. A final session was to clarify the intent of the visit to Candyland. This was likely to impact significantly on students' ability to make a connection between their preparation for the visit and the design and construction of their chocolate gift. Under the guidance of their teacher, they were to share ideas about what they might see at Candyland to help them with their design decisions (Sutherland et al., 2003) and to consider questions they could ask the presenter when they met with him. Being armed with a clear 'need to know' focus (Lambert & Balderstone, 2000) is known to have a positive impact on students' learning outcomes.

4.3.1.3 Preparing the parent-helpers

The process of preparing parent-helpers was a key element of the planning framework. Schauble et al. (2002) reported in their research that unless consideration is given to helping the helpers, the energy and resources provided to deepen a student's experience may be unproductive. Therefore, the preparation of the parent-helpers was an element of the research that was well considered during planning in order to share the teaching and learning goals.

Prior to the commencement of the technology unit, each parent in the class was to receive a letter inviting them to supervise a group of students during the factory visit, and they were given a brief explanation of the research, which was to track students' work before, during and after the visit.

On the morning of the visit, the parents who volunteered their help were to be invited to a meeting during which the goals of the visit and details of the role they were to carry out were to be described. They were to receive an information card, which listed questions they were to ask the students during the visit, and the language associated with the chocolate-making process, which they could reinforce as they moved through the factory.

In addition, they were to draw students' attention to the equipment being used, the machinery, items such as chocolate moulds, colourings and fillings, as well as the extensive range of chocolates on display. It was intended that the display, with all its colours and shapes, would encourage the students to use their imagination when deciding on the design of the gift they were to make, rather than be constrained by the style and shape of the chocolate bars and blocks that they would be most familiar with up until this point.

4.3.1.4 Preparing the factory presenter

Giving consideration to the role of the factory presenter was another critical element in the success of the visit to Candyland. The lead presenter, Lance, was very experienced in working with groups of school children, and he was equally knowledgeable as a confectionery and chocolate-maker. The environment in which he worked was spacious and the seating provided easy viewing for class groups. It was important that he understood the nature of the research and the learning intentions the teachers hoped to achieve so that, where possible, he could modify the content of his presentation. Prior knowledge of the age-group of the students and their probable responses to the factory environment was also going to be an advantage when planning his approach.

In order to facilitate this, a meeting was organised with Lance prior to the visit. The agenda for this was to explain the research project and to provide him with a modified version of the teaching unit and the learning outcomes.

4.3.1.5 Summary

The planning phase described in this section was important to the success of the following two stages, the visit to Candyland and the research, design and construction of the students' chocolate gifts for Mothers' Day. If students went on the visit with sufficient knowledge of the context, a good bank of topic-specific language, and a clear understanding of the purpose of the visit, they would be well positioned to gain the greatest benefits from the visit. Similarly, it was important that parent-helpers and the factory staff were well versed in the teaching and learning goals, and the background of the research study.

4.3.2 Organisation of the learning experiences during the visit

This section describes the intended learning to be achieved during this phase of the unit, and the organisation of the teachers, parent-helpers and factory presenter in order to achieve these. The teaching unit identified three learning intentions that were guided by the achievement objectives of the technology curriculum and are listed below in Figure 4.5.

By the end of this unit, students will be able to:
• **Planning for Practice**: identify the materials and equipment they will need, and can reasonably obtain, in order to construct their chocolate gift for Mothers' Day • **Technological Products**: describe that chocolate, as a solid material used in making confectionery can be heated, melted and used to mould into different shapes • **Technological systems**: explain that making a chocolate gift as a technological system involves a series of sequential steps including the supply of ingredients, and specific preparation and processes in order to achieve a successful product, e.g. mixing, heating, shaping and cooling.

Figure 4.4 Learning intentions relevant to the visit to Candyland

4.3.2.1 The role of the teachers

At the point where the students set off to travel to Candyland, much of the teachers' responsibility for the success of the visit would be handed over to the parent-helpers and the factory staff. During our initial planning phase, the teachers and I agreed that it would be an advantage if the teachers were free to oversee the visit rather than supervise the students. This would allow them to observe the interactions between the students and the parent-helpers as well as unobtrusively 'trouble-shoot' if the need arose. It would also allow the teachers to gather a photographic record of the visit and to more effectively follow-up on the visit once the students returned to school. A further consideration that was influenced by the research of Seifert (2006) was enabling the teachers to experience the visit as the students experienced it and, in this way, understand a little more of how it may be committed to the students' memory. It was anticipated that this would enable the teacher to better facilitate the students' recall of their experiences on their return to school.

4.3.2.2 Managing the students

Planning for the organisation of students during the visit was relatively straightforward and once underway, its success, as mentioned previously, was going to depend on how well the parent-helpers and the factory staff carried out their roles. How they were organised, however, was decided well in advance, and this was influenced firstly by (Cox-Petersen, Marsh, Kisiel, & Melber, 2003), who conclude in their research that organising students into small groups accompanied by a more knowledgeable adult results in benefits to students' learning. As a consequence, the students were placed into groups of three or four with one parent-helper. Griffin, (2004) drew attention to the Museum Visitors' Bill of Rights and signalled the importance of a visitor's comfort as well as their enjoyment and the potential for learning. The visit planning responded to this in three ways: the students were to have morning tea on arrival, time to 'stretch their legs' before the factory tour began, and they were also to have time to use the bathroom to avoid interrupting the progress of the tour and missing important learning opportunities once underway.

The tour was to begin in the retail section of the factory where the students would have the opportunity to view the ingredients and equipment required to make chocolates, and opportunity to discuss the wide range of chocolates on display. It was hoped that the huge range of colours, shapes and decorations of the chocolates would inspire the students to consider designs in their technology work beyond what they had previously experienced.

From there students were to be directed into a chocolate-making demonstration where they would observe the chocolate-making process in the factory as well as having an opportunity to make their own chocolate fish - a simple hands-on task of pouring melted chocolate into trays of small fish moulds. This task was an addition to the usual tour that was negotiated with the presenter before the visit. Rennie and Johnston (2004) argue for the inclusion of hands-on activities during an experience outside the classroom because this adds to the students' understandings and the richness of their memories.

The visit was to finish with a second demonstration during which the students would be shown how to make lollipops and boiled sweets. This was a standard part of the Candyland tour and, although not essential for the students' information-gathering exercise, we felt the second example of technological practice would be of benefit to the students' developing technological literacy. It was to be a very visual demonstration during which the students would be able to see the entire process of creating a lollipop and another useful example of product development. From the perspective of the students and the parents, Candyland was usually associated with making this product rather than the chocolates, so there was an expectation from some students and their parents that this would be part of the experience. The decision to retain this as part of the visit was not straightforward and there were some lingering concerns about the distraction that it might cause.

4.3.2.3 The parents' role

With their knowledge of the teaching and learning goals of the technology unit and the visit, and armed with the information 'prompt sheet' (see Appendix B, p. 343) containing teaching points for the visit, it would now be over to the parent-helpers to support the students in their quest for information about making chocolates. Their role was to be the 'more knowledgeable other' (Vygotsky, 1994) with the expectation that they would help interpret the factory presentations, model and encourage the use of the language of chocolate-making and generally support the students' engagement with the visit.

4.3.2.4 The role of the factory staff

Similarly, with his knowledge of the learning intentions of the teaching unit and the goals of the visit to Candyland, it was hoped that the factory presenter, Lance, would be able to modify his usual presentation and provide the students with the information they required. Lance presented as a very friendly, good-natured person and had a reputation for working well with young students. We were aware that the age group of our students would offer a number of challenges, one of which would be the perspective of the five-year-old – what they notice and what they consider to be important (D. Anderson, 2003). Typically, this age-group tends to remember the gist of events that they experience rather than gain a detailed verbatim representation, and they are likely to overlook important details of a presentation (Siegler & Alibali, 2005). How information is presented will, therefore, impact significantly on what is understood and what is remembered. Deaker (2006) signals the connection between hands-on experiences and what is remembered of an event by students. We hoped that Lance would connect visually with students by displaying objects of interest or indicating items in the factory that were being discussed rather than relying on verbal descriptions. This would provide variety and added interest for the five-year-olds in the class, and perhaps help hold their attention for the duration of the presentation (Moreland et al., 2005). It was hoped that along with sharing his specialist knowledge of chocolate-making, Lance would incorporate these teaching strategies into his practice as tour presenter.

4.3.2.5 Summary

Preparation and good planning were naturally the key ingredients of a successful visit to the factory. Certain elements of a visit such as this one are beyond the control of the teacher and, in this case, the researcher. However, an understanding of the goals of the visit and how these were to inform the development of the students' final technological outcome needed to be shared by all parties – the students, the parent-helpers and the factory staff. We hoped that through careful planning and shared understandings, misinterpretations would be avoided and each group would be better positioned to work towards the same technological endpoint.

4.3.3 Development after the visit

This section describes the planning for teaching and learning that was to occur directly after the visit. It considers the phase of consolidating student memories of the visit to Candyland, and then by drawing on this knowledge, it describes the process students would work through in order to research, design and then construct their chocolate gift for Mothers' Day.

4.3.3.1 The role of the teachers and students

(i) *Review of the visit and preparation for design development*

The role of the teachers would now to be very hands-on, guiding the students through key phases of their technology unit, whilst at the same time maintaining a strong connection with the knowledge and experiences they had gained during their visit to Candyland. The literature review presents a strong recommendation for young students revisiting and reviewing their experiences directly afterward the event (Bruck & Ceci, 1999) and within a time window after which their memories begin to weaken (Rovee-Collier, 1995; Siegler & Alibali, 2005). Drawing pictures of their experiences is known to encourage students to think more deeply about the experience and enable them to recall more detail of a visit (Siegler & Alibali, 2005). These ideas influenced the activities planned in this final phase of the technology unit, which was to begin immediately on the return to the classroom, with students drawing pictures of something they remembered from the visit. This was to be followed with discussions about the chocolate-making process they viewed during the visit and supported by reviewing the sequence of the photographs recorded by the teacher, which she would display using the classroom data projector. This was also the time to reinforce the language of chocolate-making with attention given to the ingredients, the equipment, the machinery and the sequence of activities important in product development. A follow-up sequencing activity was suggested in the teaching plan in which students were to draw three pictures showing something that happened at the beginning, in the middle and at the end of the chocolate-making process that they observed it in the factory. An emphasis on the correct sequence required for a successful solution was to be made at this point.

Whilst the images of the visit were still fresh in their minds, a final task for students would be to brainstorm all the possibilities for the look and taste of their chocolate gift. The details of this could be displayed on a chart to refer to later when they began designing their own chocolate gift. This should encourage students to consider the extensive array of colours, shapes, decorations and possible fillings seen in the retail area of the Candyland shop, which they could incorporate into their own designs. It would also be a good time to discuss the use of chocolate moulds and how these need to be filled safely and hygienically with melted chocolate in order to achieve their desired shapes.

(ii) Design and construction of the chocolate gift

The next phase of teacher planning describes the three critical design stages in technology education: (i) the students’ research into the type of chocolate their mothers prefer; (ii) the use of this information to design their chocolate gift; and (iii) with the support of parent-helpers, 'the making day' when the students create their final products for Mothers' Day.

Young students are likely to experience a more rapid loss of stored information than older students. Therefore, the provision of appropriate activities and tasks by the teacher that help reinforce, consolidate and retain the learning goals of the experience can benefit the student when applying existing knowledge to a new situation (Bjorklund et al., 1997). Accordingly, the design and construction phase of their project should briefly review what has been achieved so far and what is yet to be achieved. This can be accomplished by developing a flow chart or pictorial description of what they have done so far and how they would proceed to make their chocolate gift.

To encourage the students' critical thinking, the next task would be a teacher-led discussion about how the students could find out what type of chocolate their mother liked best. The teacher should encourage the students to consider how they might record the information, and possibly make links to surveys or questionnaires that the students may have seen used within the family. A range of simple questionnaires that novice readers are able to interpret could be presented for them to discuss. Students should begin to understand the purpose of gathering information in this way and how the information they gather will help them make decisions about their final design choice. This links to the achievement objectives in the Technological Practice and the Technological Knowledge strands in the curriculum (MoE, 2007). Ideally, the students and the teacher would then co-construct a simple questionnaire that contains minimal text, relying mostly on images and yet provides the information the students would require to inform their designs. Once finalised and duplicated, this would be distributed to all the students and taken home to gain feedback.

A key teaching point, once the questionnaires had been administered and returned to school, would be to discuss and analyse the data they had collected, understanding that consumers have different preferences, and if appropriate, that some people may have specific dietary requirements. The teacher would then introduce a simple concept of functional modelling and link this with their task of creating a three-dimensional model of the chocolate shape they had chosen to make. Three-dimensional modelling had been selected for this project because Golomb’s research (1989) into the representational abilities of students concluded that constructing three-dimensional models enabled young students to communicate an increased level of detail for their intended product, and model multiple views of their structure, compared with representing their product through a two-dimensional drawing. In order to carry out this task, the teachers would select a suitable medium, possibly modelling clay, Plasticine or a firm batch of play dough for the students to work with.

Two further teaching points would be introduced to the students at this point to explain the purpose of modelling. Firstly, a three-dimensional model could help students to decide what their chocolate gift might look like, and secondly, it would show the teacher the equipment and materials she needs to get ready for the students to make their chocolate gift. Further teaching points could be introduced as a later stage.

The research, questionnaire and modelling tasks would culminate in the ‘making day’, which was planned to follow shortly after the model-making. This would require further careful preparation and organisation, such as the availability of parent-helpers needed to be confirmed to assist the students when making their chocolate gift, an appropriate food preparation space to work in needed to be identified and booked, and the necessary ingredients and equipment located and prepared. These latter would include items such as a supply of bulk chocolate (milk, dark and white chocolate), commercially produced moulds that match as closely as possible with the students’ models, mixing bowls, spatulas, chocolate colouring powder, selected fillings and a microwave and fridge. Cleaning materials would also need to be sourced.

Because several elements of ‘the making day’ could not be confirmed in advance, the finer details would be left to the discretion of the two teachers. It was planned, however, that groups of four or five students would work with the parents, whilst the teacher continued her usual programme with the remainder of the class. Ideally this should be timetabled to occur during the 11.00am to 12.30pm block between the students’ playtime and lunchtime breaks when the students were still relatively fresh. The reasoning behind organising students into small groups during their visit to Candyland would also apply when making their chocolates.

4.3.3.2 Parents role during ‘the making day’

During this final phase of the unit, the role of the parent-helpers would be crucial to the students’ successful completion of their gift for Mothers’ Day. As previously, it would be important that they understood the teaching and learning goals of the technology unit, and understood the relevance of the research and design tasks, which the students had carried out in preparation for making their chocolate gift. The parent-helpers would be responsible for setting up a system to manage the students’ chocolate-making, and for identifying the final products the students made so they could be returned to the students at the end of the day. During this session the parent-helpers would encourage students to refer to their questionnaires as well as to the designs they had selected before beginning to make their chocolate gift. In so doing, the students would be reminded of the flavours and fillings that their mothers had selected as well as the shapes and colours they had chosen for their gift. The appropriate materials, wherever possible, would be made available for each individual student. This would enable the students to observe the results of the process they had completed and in so doing, develop an enhanced understanding of the nature of technological practice, how the individual steps inform subsequent stages, and how this can culminate in a final product.

4.3.3.3 Summary

This section describes planning for the final phase of the students’ design and construction of their chocolate gifts for Mothers’ Day. Specific teaching towards simple market research and functional modelling was expected to help students see real purpose in each of the tasks they were to carry out, and an on-going overview of preceding steps was expected to help students understand how each discrete part of the process combined with, and informed, the following steps required to create their chocolate gifts. The unit would conclude with the making of the chocolate gifts with the assistance of parent-helpers.

4.4 Chapter summary

The intervention chapter has described the planning model for a technology unit, which includes a visit outside the classroom to a chocolate factory. It has described the planning and preparation phase during which the teachers introduced the context of making chocolates for Mothers' Day, and provided a range of activities that was aimed at ensuring students were familiar with the context and the language associated with the context. This phase also included time given to the preparation of parent-helpers and the factory pressenter who were to work with the students during and after their visit. The visit to Candyland is described in some detail, along with the role of the teacher and the responsibilities of the parent-helpers and the presenters. Each has a clearly defined role aimed at facilitating a focused and enjoyable experience for the students, which would provide them with the information they required to design and make their chocolate gift. Having a shared understanding of the learning intentions of the visit and the students' technological practice was critical to the successful completion of their final goal. This phase was followed with a range of activities that clarified and consolidated the learning that took place during the visit. These included a simple research task, modelling and/or drawing a design of their chosen chocolate gift, and concluding with the 'making day' during which the students worked alongside parent-helpers and created their gifts for Mothers' Day. Throughout the teaching period, the students who were selected to participate in the research were interviewed – before the visit, after the visit, and again six months after. Samples of their drawings and stories were collected, as well as the models and the final products that they created. The analysis of the data that was collected is described in the following three chapters, beginning with Chapter 5 which focuses on the data collected before the students went on their visit to Candyland.

Chapter 5

Findings 1: Preparation for the visit

5.1 Introduction

The methodology chapter identifies two case studies, each describing a new entrant class that participated in a technology unit and, as part of this, visits Candyland, a chocolate and confectionery factory. The technological problem, which was the basis of this unit, required students to find out how to make chocolate for a Mothers' Day gift. Planning for each case study was divided into three phases of intervention, broadly described as (i) preparation for the visit, (ii) organisation during the visit and (iii) development after the visit.

Data analysis in each phase has been divided into three key areas – Technology Education, Learning Experiences Outside the Classroom, and Characteristics of five-year-olds (See Table 5.1). This chapter presents data from phase one, 'preparation for the visit'. Data from the remaining two phases - organisation during the visit and development after the visit is presented in Chapters 6 and 7. Of the seventeen students who had been selected to participate in this research, 16 took part in this phase and one student was absent.

Table 5.1 Organisation of the data chapters

Diagram showing organisation of data chapters	
The three phases of this study:	*The three areas of investigation at each phase:*
(i) Before the visit	(i) Technology Education
(ii) After the visit	(ii) EOTC
(iii) 6 months after the visit	(iii) Characteristics of five-year olds
The three headings under which each area will be organised:	
(i) Technology Education:	
Conceptual, procedural, technical and societal knowledge	
(ii) Education Outside the Classroom (EOTC):	
Understanding purpose of visit, student attitudes, preparation and link to own practice	
(iii) Characteristics of five-year-olds (Co5):	
Level of interest, transfer of ideas and language development	
The *themes* that emerge from the data and that will be described in the following chapters.	

5.2 Technology Education

Based on the framework of analysis from the Learning in Technology Education (LITE) Project (Jones et al., 2000), examination of data relating to technology education is organised under four headings, namely students' conceptual, procedural, technical and societal knowledge. These headings (or domains) were originally identified in the first phase of the LITE project in which the existing practice of a number of technology teachers was investigated. The definition of 'technical' within this study refers to students' ability to identify particular materials or components (including equipment) that might be used during the development of a product. This definition varies slightly from the conception of a 'technical domain' in the LITE project where 'technical' refers to developing manual or practical techniques (Moreland & Jones, 2000) within a technology programme. Table 5.2 below shows these headings can be broken down further into a number of themes. These themes emerged from the data of this study, the literature review, and also from the communication strand of *Te Whaariki* and the technology learning area of the New Zealand curriculum.

Table 5.2 Headings, themes and analysis of Technology Education

Headings and themes of analysis in Technology Education for the interview before the visit to Candyland
Conceptual knowledge *Students' ability to:* • engage with the context (of chocolate and chocolate making) • name a range of materials and recognise that each one has certain performance properties • recognise that materials need to be joined in order to create a product • recognise that creating a product involves a series of steps
Procedural knowledge *Students' ability to:* • describe the steps and sequence involved in making a product • identify when and where expert practice or advice may be sought
Technical knowledge *Students ability to:* • identify and name equipment required to make chocolate • identify and name ingredients used in making a food product • recognise ingredients are heated/cooled in order to create a product
Societal knowledge *Students' ability to:* • identify the product consumer as being other than him/herself

5.2.1 Students' conceptual knowledge

In this section, findings related to evidence of student conceptual knowledge are presented. Students' prior knowledge of chocolate and chocolate making is described along with their awareness of materials, material properties and how these may be combined. It was anticipated that familiarity with the context would enhance student engagement in the technological process and give greater focus to the information gathering component of their visit to Candyland.

5.2.1.1 Student engagement with the context

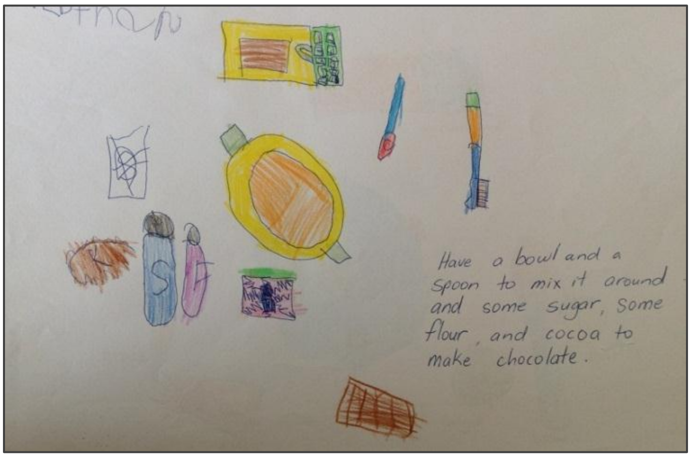
In the first lesson-planning meeting between the two participant teachers and myself, the importance of students engaging readily with the context of chocolate and chocolate making was discussed. We agreed that a student's prior knowledge, their experiences with family and during their pre-school education would be the main source of these understandings. In addition, we believed that all students in the two new entrant classes would be familiar with chocolate and chocolate making. We were confident that they would recognise a number of chocolate products, though they might not be familiar with the range of flavours available. Activities were then selected to provide the students with this back-ground information; for example, a taste-testing activity of different types of chocolate was planned in which students would sample white, milk and dark chocolate as well as a chocolate with a filling. Students would record their preferences on an analysis sheet, (see Appendix B) participate in a class discussion about their preferences and write a simple recount of their experiences. After the planning meeting, Hannah, one of the research teachers, reconsidered how she would introduce the project and chose to include a first lesson in which the students were introduced to chocolate in greater depth – she anticipated that a small number of immigrant children in her class may not be familiar with the context. She was unsure whether these children would have experienced buying and eating chocolate, or in fact, whether they knew what chocolate was. She modified her opening lesson and presented a box of Cadbury Roses chocolates, which she shared amongst the students (see Figure 5.1 below). Each child was encouraged to handle the wrapped chocolate, inspect it, smell it, before breaking it in half to see what was inside, and finally tasting it. Making good use of several cross curricular opportunities, Hannah asked the children to identify the colours of wrapping paper, the patterns and shapes cut into the paper and chocolate, and to calculate simple fractional numbers. For example, she posed the following challenge to her class "Can you bite off half of this chocolate so we can see the filling inside?" (Classroom observation, before the visit).

Another task, which was also intended to immerse the students in the technological process, was a simple market research activity in which they discussed and then took home a survey form for their mothers to fill out. This form asked for information about her favourite chocolate. The children were required to colour in the emoticons that best described their mothers' reactions to each of the listed chocolates – white, milk and dark.

Figure 5.1 Students' inspection of a Roses chocolate

These experiences would help students from both classes to become familiar with the context. They were then well-prepared and able to participate in the activities with some basic understandings and increased confidence.

All 16 students across both classes took part in the first intervention task, which aimed to identify their existing understandings of chocolate and how it could be made. Each student was asked to draw a picture to describe how chocolate could be made. They then either wrote or dictated a story to their teacher describing their drawing. Fourteen of these students referred to chocolate in their story or drew pictures of chocolate, with some students adding simple labels – usually the initial letter of the word they were describing. One of these students wrote the following story to describe how chocolate could be made: "Have a bowl and a spoon to mix it around, and (put) some sugar, some flour and cocoa to make chocolate" (Nick, first drawing, see Figure 5.2).



Text:
Have a bowl and spoon to mix it around and some sugar, some flour, and cocoa to make chocolate.

Figure 5.2 Student drawing and scribed story showing how chocolate might be made

Whilst we could assume that the remaining two children were describing chocolate, there was no clear evidence in their stories to show they were familiar with chocolate-making. For example, Kristy drew a picture of a bowl of sugar and some cheese and she was able to name each of these items but unable to describe how they might be used to make chocolate.

The second intervention task was a taste- testing activity in which students sampled three common flavours of chocolate - white chocolate, milk chocolate and dark chocolate. After each taste test students completed a simple response sheet by colouring one of three emoticons to signify their reaction to the three types of chocolate – a laughing face, a smiling face, or a serious face. Because one student was absent at the time, 16 of the 17 again students completed this activity. Their ability to discriminate between the different types of chocolate and to respond appropriately was evident in their taste-testing analysis sheet. Three female students recorded the same expressions for each type of chocolate, but the remaining 13 students varied their responses, generally indicating they enjoyed the white and milk chocolate but were less positive about the dark chocolate. At the conclusion of this task, all students had participated with high levels of enthusiasm. They were clearly familiar with the three chocolate flavours in the taste-testing exercise, but it was evident that many had only simple understandings of the chocolate-making process. The opportunity to participate in these activities resulted in multiple benefits, one of which enabled all 16 students to engage more confidently with the context of chocolate and chocolate-making. It was anticipated that students' prior knowledge and recent experiences within the technology unit so far would impact on the construction of new understandings during both the factory visit and post-visit activities.

5.2.1.2 Students' knowledge of materials, their properties and how to combine them

Product development in any form requires the use and manipulation of materials. The ability to relate the properties of materials to their use in producing a technological outcome is a key element of successful technological practice (Frederik et al., 2010). In order for students to select appropriate materials for their product development, they require knowledge of available materials, an understanding of the performance properties of these materials and how each one could be manipulated in order to construct the solution (Frederik et al., 2010) to their technological problem.

Data that illustrates students' knowledge of materials was gathered from 16 interviews before the students visited Candyland, and from 17 students' drawings and stories which described how they thought chocolate might be made. Two items were used to help focus the interviews: a small, fabric 'academic' bear, and a chocolate-coated frog labelled Freddo Frog. Students were asked to describe how they thought each item would be made. When examining the data, 11 students referred to materials they believed would be used to make the products, often with a modifier such as 'by', 'with', 'using'. Prompting usually led to more materials being listed and included common items such as cotton, string and sheep's wool. The remaining six students struggled to answer the questions and their responses suggested they were unaware of the significance of materials in the construction of each of the above-mentioned items. When specifically asked about process, the students generally responded by referring to the materials used. As an example, Isla described how the academic bear would be made.

R **Have a look at this little bear. Do you think you can tell me how you think the man or lady who made that ... did it?**

I They made … they did it by using cotton.

R **So they need some cotton … how else do you think they would make it?**

I	By … by string.

**R	Where's the string?**

I	Inside

**R	You think there's some string inside? Okay. What about these little bits … How do you think they would have put that together?**

I	With some material glue (Isla, first interview).

A further examination of data revealed that students were mostly unaware of material properties. As indicated in the previous paragraph, some materials were named by the students, but there was little evidence they considered either the form or function of the materials. A vague indication of the students' awareness of function may be seen in naming glue as a joining agent by three students, and reference to sheep's wool which two students understood to be a suitable soft filling for the bear. Similarly, students demonstrated little appreciation of materials needing to be joined or mixed in order to create a product. Without specifically prompting the students, there was only one example of this which arose during my interview with Dana.

R [Researcher] How else do you think the people (at the factory) would make the little bear?

D	(No response)

**R	What else would they have to do?**

D	They'd get some tools.

**R	Some tools? Mmm hmm – and what would they do with the tools?**

D	They would make sure that all the fluff is all stuck together (Dana, first interview).

It appears that students' understanding of materials, material properties and how these can be combined to make a product, is limited to the naming a small number of raw materials. These students' attention to materials only, appears to be consistent with the observation that young children begin to solve a technological problem by exploring materials (Fleer, 2000). The students seemed unfamiliar with the properties of materials and, therefore, struggled to anticipate the processes necessary to convert these into a final product.

5.2.2 *Students' Procedural Knowledge*

Findings related to evidence of student procedural knowledge are presented in this section. Procedural knowledge refers to students' understanding of the key phases of their own practice, and the sequence required in designing and creating a product. Young children have a tendency to consider a problem or give an explanation in separate parts without always connecting them coherently (Fleer, 2000). Moreland et al. (2000) describe this as "knowing how to do something, what to do and when to do it" (p. 3). Data which describes five-year-old students' knowledge of process is presented in the following paragraphs.

5.2.2.1 Knowledge of the steps and sequence involved in making a product

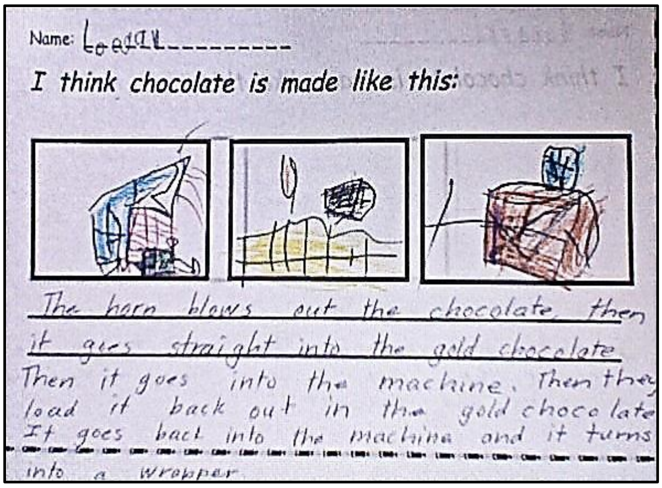
In order to identify students understanding of technological practice, interview questions were again based on the chocolate frog, and the academic bear. The students were asked to describe how they thought these items were made. The method of analysis was based on the number of steps that students were able to describe. Each step that was counted represented one discrete part of the production, whether or not it was correct.

Figure 5.3 Two items used to analyse student procedural knowledge, a chocolate frog and the academic bear

An associated activity designed by Hannah, that also investigated students' prior knowledge of technological process, focused on how chocolate was made. Students were asked to create a sequence of drawings to describe a three-stage process – how you would begin the task, something that should happen in the middle and a picture to show a final stage. This is presented in Figure 5.4.

The interviews, drawings and stories referred to above provided a source of data for investigating students' procedural knowledge. The use of multiple techniques allowed for the triangulation of data, and this in turn helped remove some of the uncertainty associated with interpretive analysis. The interviews, followed a set of prepared questions, but the questions were relatively open-ended, and students' responses were often prompted, in order to gain any further information they had to share. In comparison, students' drawings and scribed stories were accepted without further intervention.

Deciding how the typical five-year-old might respond to this task was difficult to determine, so it was necessary to draw on the expertise of the teachers participating in the study and to construct a simple task that would provide a structure for students to report what they knew. Hannah gave each student a blank template for drawing, (see Figure 5.4), and on completion wrote their dictated descriptions of each picture underneath.



Text:
The horn blows out the chocolate then it goes straight into the gold chocolate. Then it goes into the machine. Then they load it back out in the gold chocolate. It goes back into the machine and it turns into a wrapper.

Figure 5.4 A completed template showing how chocolate might be made

Rose's class carried out a slightly different task in which each student drew a single picture and then dictated ideas about the chocolate making process for her to write underneath.

As previously, 16 students participated in both the first interview and the drawing and story-writing task. Two levels of thinking emerged in this data: (i) those students who included the materials and equipment needed in the construction of the product, i.e. the chocolate frog and the fabric bear, but did not express any notion of process, and (ii) those students who attempted, often inaccurately, to express a series of steps that explained how the product might be made. Table 5.3 shows data gathered from students at Oldpark School (frequency counts reflect the number of students mentioning that number of steps for each item, whether the step was accurate or not).

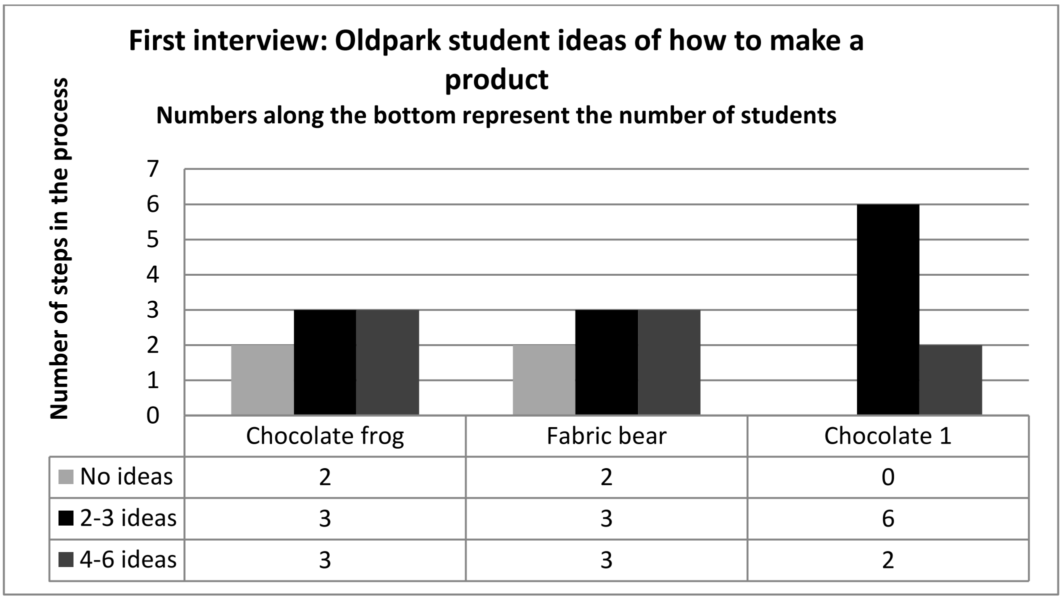


Figure 5.5 Students' ideas of the steps required to make a product

Technology Education, even at its most simple level, requires students to understand the importance of correctly sequencing tasks. It also requires them to connect the stages of a technological process in order to achieve an outcome rather than viewing each activity as an end-point in its own right.

Of the 16 students who participated in either or both of the above mentioned activities, 13 demonstrated a beginning sense of sequence. Their ideas were at times inaccurate because of lack of context specific knowledge, for example the student who thought the fabric bear may have been knitted, but had no knowledge of knitting patterns or the process involved in knitting a toy. This student described shaping the toy after the knitted fabric had been completed rather than as a consideration incorporated into the knitting pattern. Other students described a logical starting point for the construction of the product followed by a small number of steps loosely describing how it could be made. Nick described how chocolate could be made in this way:

R How do you think the people at Cadbury's might have made Freddo Frog?

N Umm … did they put sugar?

R They put sugar in … what else might they do to make him?

N They might put milk and they might put … cocoa …

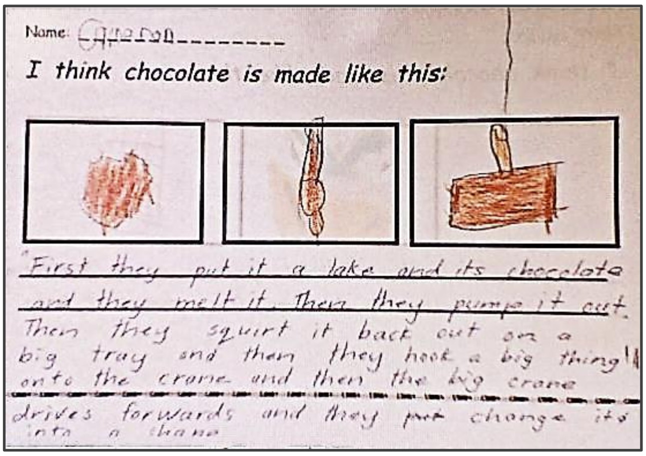
R Cocoa in … right, sugar, milk and cocoa …

N And then they'll stir it and then they'll it will come out like this.

R Okay, good thinking … how do you think they might get that little shape?

N Umm … they have a shape and it's like the frog and then they press down on the chocolate.

Twelve students described the construction of products in two to three steps, and five students were able to describe the process of making the chocolate frog in greater detail, usually four to five steps. The manner in which they structured their descriptions varied, but generally one or two ingredients or materials were named and a reference to either machines, wrappers or shapers were included to complete the process.



Text:
First they put it in a lake and its chocolate, and they melt it. Then they pump it out. Then they squirt it back out on a big tray and then they hook a big thing onto the crane and then the big crane drives forwards and they change it into a shape (Kris 1st drawing).

Figure 5.6 Kris's sequence of drawings that show how to make chocolate

The six students who presented more detail in their descriptions referred to the use of tools, stirring a mixture, putting the product into a freezer or joining materials, e.g. cutting or sticking. The unprompted drawings and stories generally provided less detailed descriptions with the exception of two students, one of whom offered this response (shown in Figure 5.5).

Five-year-old students in this study tended to describe process in terms of the materials, ingredients and sometimes equipment which are part of the product development. They could draw on prior experiences, usually uncritically, and with prompting could provide explanations that were simple, but that gave one step at a time. There was a sense of order and sequence in some of their descriptions.

5.2.3 Technical Knowledge

Technical knowledge in this study refers to students' ability to identify particular materials or components (including equipment) that might be used during the development of a product. In their briefing paper informing the development of technology in the New Zealand Curriculum, Compton and France (2006) identified three categories of particular interest, one of which was technological products. This was adopted by the New Zealand curriculum as one of three strands, and is currently described as students' "ability to identify the particular materials, components and/or software they might use" (Ministry of Education, 2010b). In this section, therefore, students' ability to identify the equipment and ingredients required to make a nominated product is identified.

5.2.3.1 Knowledge of equipment

Students' knowledge of every day equipment was assumed to be largely dependent on the experiences and interactions they had had with their families, in the community and with their pre-school teachers.

The data for this section of the research was again gathered through the collation and analysis of students' first interviews and their pre-visit drawings and stories. Eight of the students made no mention of the equipment required for making chocolate, and all but one of these students seemed unaware that machinery might be important in the process of developing a product. The remaining students named or approximated a range of items but there was little consistency between their responses. This is demonstrated in Table 5.4 below.

An awareness of the function machinery might play in the production of chocolate was expressed by eight students. Three students expected to see machines at the factory, four described machines as being part of the chocolate-making process, and one student considered there would be no machines at Candyland.

Table 5.3 Children's ideas about the equipment required to make chocolate

Oldpark students' ideas about equipment used in chocolate making			
Dana	Tools	A special pen	
Nick	A bowl	Something to stir it	A shape
Lizzie	A special knife	A recipe book	A big freezer
Rosie	Boxes	A big sign out the front	
Sean	A shaper	A shape thing	
Kristy	Some equipment	A little container	A bowl
Olivia	A muffin tray	A spoon	
Zoe	A recipe book	A bowl	

Whilst students were mostly accurate in the names they used to describe equipment, some approximations were used to help express their ideas. A 'shaper' or a 'shape thing' was used by three of the students to describe cutters, and a 'horn' was used by another student to describe a chute or a tube for moving liquid chocolate. In comparison, machinery was a generic term used by the students and this encompassed a wide range of different types of machinery. Despite the students being unable to name these at this stage, they were did anticipate some of the functions they would carry out – they referred to machines to make chocolate, machines to shape chocolate and machines to wrap chocolate. One student responded to my question about shaping the chocolate frog in the following way:

R **How do you think they (the factory staff) would have got that little shape?**

D Out of a machine thing.

R **What sort of thing?**

D Um … what makes the shape.

R **The thing that makes the shape … yes, you're right, good girl. What about the writing and little eyes there, how do you think those were made?**

D They would put a little special pen what goes on chocolate (Dana, first interview).

The students also made reference to the use of ovens, microwaves and fridges and this is discussed in the next section.

5.2.3.2 Knowledge of ingredients

Data describing students' ability to identify ingredients that a chocolate (or nominated) product is made from, presents useful base-line data from which to determine pre-visit teaching and preparation. The working vocabulary of five-year-old students is quite extensive and Campbell (2006) credits this age-group with 6,000 to 12000 words. Fostering context -specific vocabulary in technology education is vital in providing tools that will enhance students' ability to think about and communicate their ideas when engaged in technological activity. This knowledge may again be generated by both the experiences of their home and family life as well as their pre-school education.

At this early stage of the intervention, students tended to focus on naming ingredients rather than describing stages of product development. Ten of the 16 participating students listed a number of ingredients when describing how they thought chocolate would be made. These ingredients tended to be commonly known food products such as milk, flour and butter, with 6 of the 10 students including sugar in their descriptions. The same number of students believed that chocolate would be included as one of the ingredients if you wanted to make chocolate, and four students listed items that were chocolate brown in colour, for example cocoa, Coca-Cola and 'brown stuff' (presumably also cocoa). One student, who had carried out some research at home with his parents, included cocoa beans in his description.

5.2.3.1 Student knowledge of heating and cooling

Understandings of whether the chocolate needed to be melted, heated or cooled when it was being made were very limited. A typical response came from one student when she described this process in her story writing: "Put the brown stuff in a bowl. Mix it up, melt it in the microwave, put butter in, put flour in and then baking soda. Put it in the oven (Dana, 1st drawing)”. Another student said, “They put it in the sun and cook it (Mana, 1st drawing sequence)” and a third stated, “They put milk in it, then they turn it into chocolate (and) put it in the oven (Kayne, 1st drawing sequence).” Two students, who included a picture of a microwave in their drawing, didn’t refer back to it in their dictated story. An example of one of these drawings is seen in Figure 5.6.

Other data indicates that, though several students understood chocolate needed to be hardened before it could be eaten, chocolate was not generally associated with cooling or refrigeration. One exception is a description by Lizzie during her interview in which she stated that the next stage in the process of making chocolate would be to “put it in the big freezer … so it gets hard”.

Text left to right:

Coca cola
knife
flour
a pot
microwave
bag of sugar
spoon
butter

Figure 5.7 Andrew’s initial drawing showing ingredients and equipment required to make chocolate

From a technical perspective, therefore, students were generally conversant with common, everyday ingredients used in preparing meals, but less aware of the equipment and processes required to develop a product. With prompting, some students were able to describe a simple series of steps required to make the academic bear or the chocolate frog and usually demonstrated a beginning awareness of sequence. Understandings of whether the chocolate needed to be melted, heated or cooled when it was being made were negligible.

5.2.4 Societal Knowledge

Evidence of societal knowledge was not found in the preparation for the visit phase. Findings related to this area emerged after students had participated in the pre-visit activities and completed the visit to Candyland. This is presented in the two following chapters.

5.2.5 Summary of technology education pre-visit findings

The data gathered from students during interviews and from their drawings before the visit to Candyland showed quite clearly that the new entrant participants in this study were excited about going to the factory, they had a range of expectations of the visit which included what they would see and learn, and they willingly participated in the activities provided. This data indicated that the students had a wide range of prior knowledge and experiences and this was referred to as they attempted to make sense of the forthcoming visit.

Questions designed to probe their thinking about the process of general product development mainly resulted in answers that described ingredients, equipment and materials although with prompting, some students indicated a beginning understanding of the steps and sequence involved in the production of a product. The students’ knowledge of materials and material properties was limited and this had an impact on their ability to anticipate the processes necessary to convert these into a final product. They were more familiar with a range of common ingredients used in everyday food preparation but the equipment used to combine or mix these was absent in their responses. Most were unaware of the need to heat or refrigerate ingredients. Several students recognised the need for machinery in a factory and the specific function these may have in the production line. Limited language and experience appeared to prevent them from describing these in detail.

5.3 Education Outside the Classroom (EOTC)

The literature identifies several important considerations when planning a learning experience outside the classroom. The knowledge and experience a child brings to a visit is a significant factor in constructing new understandings. In addition, the personal relevance of tasks, along with students’ motivation and a ‘need to know’ factor, have an impact on their willingness to engage effectively with the complete experience. These views were considered when planning the introductory stage of the teaching unit, and the teachers incorporated and developed them as they saw fit.

In order to analyse the factors listed above, each one has been further defined by a number of themes, which emerged from the data and were highlighted as being important in the EOTC literature. This section presents data associated with these factors and is described according to the themes listed in, Table 5.4.

Table 5.4 The themes for analysis of EOTC data

Themes for analysis of Education Outside the Classroom
a) Students' understanding of the purpose of the visit Ability to: • explain the purpose of the visit • link the visit to his or her own technological practice
b) Students' attitude towards the visit Ability to: • express feelings towards the factory visit • explain a reason for their response
c) Students' preparation for the visit to Candyland Ability to: • offer ideas for preparing for the visit • identify questions to ask the presenters during the visit
d) Students' expectation of the visit to Candyland Ability to: • anticipate what might be seen during the factory visit • anticipate what the students might do during the factory visit • recognise potential learning opportunities • recognise the role of the staff
e) Students' views of their learning Ability to: • Identify the expected learning opportunities of the visit ▪ the learning or help gained at the factory ▪ the role of the staff
a) The frequency of students' visits to Candyland

5.3.1 Student understanding of the purpose of the visit to Candyland

At the beginning of this project, the teachers and I met to plan the three phases of the visit: preparation for the visit, management during the visit, and follow-up activities leading to the design and construction of the students' chocolate gift. The final teaching plan listed several important steps (listed below) that we thought would impact on students' understanding of the purpose of the visit.

- Clearly establish the need or opportunity for the unit and the problem students are to solve – “How can we make chocolates for Mum that are safe to eat and are Mum’s favourite?”
- Develop a simple plan for students to follow that would help them solve the problem of making chocolates for Mum
- Identify Candyland as a site to gain expert advice
- Establish students’ existing knowledge and build on this
- Identify questions that could be put to the Candyland staff (Teaching plan, before the visit).

In this section, findings related to evidence of students’ understanding of the nature and the purpose of the visit, are presented. These include students’ attitudes towards the visit, their ideas about preparing for the visit and how the visit relates to their own technological practice.

Three of the 17 students from Dayton and Oldpark Schools, Isla, Dana and Clarke, had visited Candyland previously, either with family members or with friends. It was expected that the responses from these students could be influenced by their earlier experiences at the factory.

The literature suggests that an important element of any learning experience outside the classroom is students’ understanding of the purpose of the visit, and being able to approach the visit with a ‘need to know’ factor.

There was some variation between the responses of students from the two schools about the visit purpose. Of the eight participating students from Oldpark School, all but one student were able to accurately express the purpose of the visit to Candyland. For example, in response to a question about why the class was going to visit Candyland, Sean said, “’Cos we’re going to make chocolate, ‘cos we want to know how to make chocolate”. Interestingly, although Kristy was very clear during the interview about why she was going to Candyland, she reported to her parents that she was going there “to eat candy”!

Students from Dayton School expressed a range of ideas to describe the purpose of their factory visit, including going on a trip, and to make chocolate and lollipops. One student from this school was a little more accurate and said, "Because people were buying chocolate for their mums for Mothers' Day and they like it and so we're going to find out about chocolate". Understanding the link between knowing how to make chocolate and making their own chocolate was somewhat tenuous, but four of the eight students from Oldpark School were able to make this connection during their interviews. For example, Rosie explained quite simply that, "We're going to make chocolate for Mothers' Day". None of the students from Dayton School expressed the relationship between 'the knowing and the doing' – between going to the factory and then making the chocolate gift for Mothers' Day. Isla's response to my question is typical.

R **Do you know why we're going to Candyland tomorrow?**

I No.

R **You don't know? Would you like to have a guess at why you think we're going?**

I Umm … we have … lots of people have chocolate for Mother's Day.

R **Right, so if … so do you think there's any special reason, anything special that you want to find out when you go to Candyland tomorrow? [… …?]**

I Umm … it's … it's … umm …

R **You're not sure?**

There is evidence to suggest that the intent of the visit may have been underplayed by Isla's teacher prior to the visit, with attention given instead to ensuring the students were adequately prepared for engaging with the context of chocolate-making. These students participated in two taste-testing activities, read simple texts with their teacher that described chocolate and chocolate-making, and received teacher feedback and discussions designed to extend their oral language. This phase of preparation was different at Oldpark school and at one point the release teacher (the teacher who releases the classroom teacher each week for special duties) explained to the students that "This (the visit) is not just about fun, we are going to find out how to make chocolate" (Classroom observation, lesson before the visit). The interpretation of the teaching plan by the teachers, and their attempts to modify this to suit the needs of the two classes, appears to have impacted on students' understanding of the reason for their visit to Candyland.

5.3.2 Students' attitude towards the visit to Candyland

The literature suggests that moderate to high levels of interest and enjoyment experienced by visitors to a special event or site will result in greater benefits for the visitor, compared with those with higher entry knowledge but less interest (Falk & Adelman, 2003). When we were preparing for the factory visit, we made sure that the site was appropriate for new entrant students, and that it offered exhibits and presentations that were potentially appealing to this age-group.

For example, the visit was to include time to explore the factory shop so students could see the extensive display of chocolates, particularly the range of shapes and colours of chocolate (see Figure 5.8), they would have an opportunity to make a small chocolate fish, listen to a presentation about chocolate and chocolate-making, and conclude with the chance to observe how boiled sweets and lollipops are made.

Figure 5.8 A chocolate item from the factory

It was anticipated that this would create an experience that was multi-sensory and would include hands-on activities and exposure to a working environment that offered all the noise, aromas and excitement of an authentic factory production line.

As anticipated, all 16 students offered positive comments about the proposed visit during the first interview. They expressed their feelings using simple descriptor such as excited, happy or good.

Providing a reason for their response was more challenging and five students were unable to give a precise reason for their excitement other than comments such as "Cos I'm looking forward to going" (Kristy1st interview) or "Because it's going to be fun" (Sean, 1st interview). One student anticipated she would "get to see lots of things … umm …the special-est things" (Dana, 1st interview) and another said she was happy “because my Mum’s going to be helping” (Isla, 1st interview). Positive attitudes to the visit appeared to be mainly linked to having fun, seeing new things and who else was going on the trip.

5.3.3 Students’ preparation for the visit to Candyland

Teachers planned to prepare students to go on the visit armed with questions,

which, if answered, should assist them in solving the problem of how to make chocolates for Mothers’ Day. This required students to be clear about the purpose of the visit and, equally importantly, they needed to keep in mind the final outcome that they were to produce. It is well-known that five-year-olds view a technological process of this type in its individual parts, without understanding that each phase is part of a more extensive process. For them, each activity can be an end-point in its own right (Milne, 2002). In response to this, the teaching plan incorporated the following prompt, ‘Establish what students need to know or find out in order to solve the problem of making chocolates for Mum’. This was to be done very early in the process, and referred back to at each new activity, so that the students would keep in mind their own technological ‘end-point’.

The questions students intended asking the presenters at the factory, along with the interview questions associated with their preparation for the visit, revealed a limited but mixed response. The students were asked if there was anything special they needed to find out about when they went to Candyland or whether they had any questions they needed to ask. Oldpark students had spent some time formulating questions with their teacher (see Figure 5.10), but most were unable to refer to this during the interview. Two students planned to ask how chocolate was made and one student intended finding out about “candy and stuff’. Kris from Dayton School said he has no questions to ask but he would “put on a jumper ‘cos it might be cold”. The interview question did require them to apply a more complex analysis of the reason for the visit as well as articulating how it might be achieved. It would appear that, though students of this age are competent in asking for help, directions, or for an item they need in their day-to-day lives, they were not forthcoming in this discussion and may have been challenged in making the link between the planned visit and the information to be gathered.

5.3.4 Students' expectations of the visit to Candyland

An important element of an EOTC experience entails participants having a positive attitude towards potential learning opportunities. Students are advantaged if they are aware of how their visit is to unfold and if they perceive the experience as an information-gathering experience, during which they can begin to develop design ideas for their own chocolate-making project. A teaching step included in the teachers' plan stated that teachers should 'familiarise students with the expected programme of the visit'. This was to include exploring the factory shop to see all the different types of chocolate, listening to a presentation by the one of the staff on how chocolate is made, and participating in two hands-on activities during which students would make a chocolate fish and a lollipop. This was designed to be an appealing and memorable visit for these five-year-old students.

Armed with this knowledge, it was anticipated students would embark on their visit with a clear focus of what was to be achieved, and a desire to solve their problem of how to make chocolates for Mum.

An interview question that asked whether students had any ideas about what they might see at the chocolate factory received 12 responses. Students' answers varied quite markedly, as did the focus of their answers. Some students seemed aware of the chocolate-making function of the factory and the items that may be required to achieve this, whilst others anticipated seeing sweets of different kinds. Seven students from Oldpark School responded with suggestions of items that they thought would be part of the chocolate-making process such as machines, bowls and ingredients. Two students named ingredients including cocoa, milk and cocoa beans. The five (5/7) students from Dayton who responded to this question expected to see a range of sweets and named candy canes, candy sticks, lollipops and jelly beans. One student said he expected to see "lots of candy and chocolate and stuff" (Clarke, first interview) and Nick made the following suggestions.

R Have you got some ideas of what you think you might see out there?

N Machines.

R Machines, right … good thinking. What do you think those machines might be for?

N Making chocolate.

R **Okay … any other ideas of what you might see out there?**

N Umm … a bowl.

R **A bowl, yes. What would that bowl be for?**

N To put the chocolate in (Nick, first interview).

Apart from two students, one who was absent on the day of interview and one who did not answer the question, the students listed products, ingredients or equipment as items they might see at Candyland. The answers they provided indicated that they had some expectations of the visit, but these were not necessarily related to finding out how to make chocolate. Again there was variation in the responses from students at the two schools – Oldpark students tended to talk about items relating to chocolate-making and Dayton students generally referred to candy, candy canes and other similar products they might see.

The literature review of this study reports on the impact students' expectations of learning opportunities can have on what they notice and what they remember during a learning experience outside the classroom. Several questions were put to the students during the interview to gain an understanding of what they thought they would find out at the factory. The format of these questions varied slightly between the students but usually they were asked questions such as, "Are there any questions you might have for the people (at Candyland)?" or "Have you got any special questions that you want to find out?" The mixed response to these questions may have been complicated by five-year-olds' limited understanding of the questions. Three students responded by providing answers rather than questions, e.g. Dana thought she would find out that, "We need some machines to make it (chocolate)", and Kris thought he would learn "not to eat candy 'cos its rots your teeth". Four students expected to find out how to make chocolate or candy, and two wanted to know which ingredients to use. For example, Dana said:

R **Are there any questions that you might have for the people?**

D Sugar.

R **About sugar? What do you think you might ask about sugar?**

D Do you use sugar for the chocolate? (Dana, first interview)

Interestingly, Rosie believed she would not learn anything new at the factory, as she learnt things "at school and at kindy", not at a factory. Similarly, her twin sister Olivia understood that her teacher would provide her with any new information. She made the following comment:

> **R Have you got anything special that you need to find out about when you go to Candyland?**
>
> O [My teacher] will tell us.
>
> **R If you learn anything new [your teacher] will tell you?**
>
> O Yeah.

The remaining eight students were unable to describe new learning opportunities. These perceptions of potential learning opportunities are significant in EOTC. The research indicates that, where a visitor to a site has a specific personal interest or a desire to gain new knowledge, the learning outcomes are greatly enhanced (D. Anderson, 2003; Falk et al., 1998). It is apparent that over half of these young students, despite having a general understanding of the purpose of the visit to Candyland, lacked any real perception of how, and from whom, this information might be obtained.

5.3.5 Student understanding of the role of staff at Candyland

Students' perceptions of the role staff have in a factory could impact on whether or not they see the site as a legitimate learning environment. Highlighting their role as experts who could help answer students' questions, gives added status to the presenters and allows students to view them as teachers – people who will provide them with information. Though this point was clearly understood by the teachers during the initial planning meetings, it was not highlighted in the teaching plan. Discussions associated with why we were going to Candyland and what we needed to find out did not include mention of the two staff members, Lance and John, or the educational role they were to carry out.

An interview question that asked students what they might see at Candyland resulted in answers that not only indicated their awareness of the products and ingredients, but to a lesser degree, the people who might be at the factory. Questions that pursued this line of thinking a little further resulted in a small number of responses, with most students unable to provide an answer about 'the people' – there was noticeable shoulder-shrugging and head-shaking at this point of the interview. The six (6/17) students who were able to respond expressed a range of ideas, most of which required persistent prompting by the interviewer. Four students expected to see people making chocolate or candy at the factory, and one student thought people would be visiting the factory so they could buy candy. With encouragement, Kris offered the following thoughts.

> **R What do you think the people might be doing out there?**
>
> C Eating candy.
>
> **R Eating candy … any other ideas about the people.**
>
> C Walking.
>
> **R Walking around … they could be.**
>
> C Walking around to see what there is.
>
> **R Yes, there will be. And do you think there's any people out there with some special jobs to do.**
>
> C Make candy (Kris, first interview).

One student surprised me with her very inventive, if somewhat confused, response. Zoe imagined there would be "little people" at the factory "like elves or something" who would be making the chocolate – an idea possibly originating from the movie *Charlie and the Chocolate Factory*.

Included in this section of the interview was an attempt to find out what students anticipated they would do at the factory – how they saw their own role during the visit. Was this to be a very passive role or did they see themselves as active learners on a mission? Once more there was much shoulder-shrugging in response to my questions, with the only exception being a very succinct though slightly inaccurate response from Kris. He said, "I am going to Candyland and I'm going to make a lollipop". Reflecting on the results so far, it appears that students' awareness of staff and visitors to the factory was generally limited but their expectations of seeing chocolates, sweets and items of equipment was expressed with greater frequency.

5.3.6 Summary of Education Outside the Classroom pre-visit findings

Planning the technology unit and visit to Candyland involved collaboration between myself, as researcher, and the teachers, Rose and Hannah. The social and cultural make-up of their two new entrant classes was quite different, as were the learning needs of both classes. Rose and Hannah interpreted the teaching plan according to their knowledge of their students and, as a result it was observed that, while most aspects were covered very thoroughly, some parts of the plan were overlooked, some were highlighted and others received only a cursory examination. This appears to have had an impact on the students' understanding of why they were visiting Candyland. Data from this study shows that over half the students understood they were to gather information to help make their Mothers' Day gift, but few were able to describe a question they needed to ask to the presenters. The remaining students tended to focus on the chocolate and sweets they expected to see but did not indicate a connection between these and solving their own design challenge. The attitude of all the students towards the visit was positive and they appeared to link this to having fun, seeing new things, and having a parent or friend to accompany them on the trip. They embarked on the experience with some clear expectations but these were not always linked to making chocolate. In summary, it seems that although over half of the student had a general understanding of the purpose of the visit to Candyland, there was no perception of how and from whom, knowledge about chocolate-making would be obtained.

5.4 Characteristics of five-year-olds

The two previous sections have focused on student learning in technology education, and student understanding of, and engagement with, the EOTC experience. The visit to Candyland was an integral part of the technology unit and provided students with an authentic experience from which they could draw information and ideas for developing their own product. This section of analysis from phase one, Preparation for the visit, aims to investigate three components of learning typical of five-year-old students. These are discussed under the following headings: (i) interest and participation, (ii) transfer and application, and (iii) language development. I propose these are central to teacher planning when integrating technology education with EOTC. The themes that reflect these ideas are listed below in Table 5.5. They allow for an in-depth analysis of data from the students' first interviews, the document analysis of their drawings before the visit, and a recorded interview with two parents who attended the visit to Candyland.

Table 5.5 Table showing three headings and themes that characterise five-year-old behaviour

Themes for analysis of the Characteristics of five-year-olds
Interest and participation Students' demonstration of: - an interest in the context and a willingness to undertake the technology and EOTC experiences which were offered
Transfer and application of ideas Students' ability to: • extend what has been learned in one context to new contexts
Language development: Students' ability to use language skills for increasingly complex purposes, i.e. • use (simple) language skills for expressing feelings • use (simple) language skills for guessing • use language skills for reasoning and probability • use a range of topic specific words to create meaning • use a range of personal-content words to create meaning • substitute conventional language with similar known vocabulary to convey meaning • ask a question (Ministry of Education, 1996; Ministry of Education, 2007a)

5.4.1 Students' interest and participation in the chocolate-making context

The decision to take the students to Candyland was the result of collaboration between the teachers participating in this study and myself. We agreed that a context in which food was the central element was likely to attract the interest of all students, and confectionery had been the successful focus of other visits. It was acknowledged that the relevance of the site would impact on student engagement as would their expectation of gaining new knowledge, i.e. embarking on the visit with the motivation of a 'need to know' focus as well as the belief that questions about making chocolate would be answered.

The influence student interest has on learning is well documented. Falk & Adelman's (2003) research on museum visitors' recollections of science exhibits argue that those visitors who had a moderate to high interest in the exhibits, but limited knowledge, were the main beneficiaries. The end-point of this integrated unit of work was students making chocolate to give to their mothers on Mothers' Day. Their ability to focus their attention on how to make chocolate during their visit could have significant impact on the eventual development of their technological outcome – the chocolate gift.

The data presented in Section 5.3 showed that all students were positive about the prospect of the visit to Candyland, several thinking it was going to be "good" and some saying they were excited about going.

Over half of the students understood why they were going to Candyland and four students were able to link this to their own practice, i.e. they were going to find out how to make chocolate at Candyland so they could make a chocolate gift for Mothers' Day. Olivia's very clear reply to my question about why we were going was, "We're going to make chocolate for Mothers' Day" (Olivia, first interview).

Young students are known to progress through this type of process without really 'joining the dots' – unable to see the links between each step of the process and having a tenuous connection with the final outcome of the project.

It was anticipated that students would be better positioned to manage the process of gathering information at Candyland and applying it to their own design and making of the chocolate gift for Mothers' Day if there was a high level of student interest and a clear knowledge of the purpose of the visit to the factory.

5.4.2 Students' transfer of ideas and application to a new context

Prior knowledge is a significant factor in student learning. In this study, students' ability to apply prior knowledge to new experiences has a strong influence on subsequent knowledge development. Prior knowledge forms the basis of an EOTC experience and is one of the fundamental reasons why this particular genre of teaching is deemed so valuable. In this section it is discussed under the theme of transfer and application.

The constructivist view of learning holds with the notion that learning is the process of applying prior knowledge and experience to new experiences (Rennie & Johnston, 2004). An outcome of both technological activity and a learning experience outside the classroom is that students will transfer the knowledge they have gained in order to understand or interpret new experiences. This analysis seeks to identify instances where students transfer understandings from an earlier experience in order to interpret a new one, specifically where it applies to a technological process.

In the student interviews held during the preparation for the visit, there were several examples of students drawing on prior knowledge to name materials or equipment, for example, sheep's wool, glue and recipe books, as well as a range of ingredients described in Section 5.2.4 of Technology Education, under the theme of 'topic specific vocabulary'. When explaining the technological process involved in assembling the chocolate frog and the academic bear, three students were clearly reflecting on earlier experiences and applying these understandings to the construction of the unfamiliar products. Kris explains how the shape of the academic bear could be made.

R **So if you were trying to make that little bear, how do you think you might make the shape?**

C Draw around the shape.

R **That's a good idea.**

C And cut it out.

R **Cut it out … good thinking … and then what would you do?**

C Stick it on a piece of paper and make it all up and then copy it.

R **How do you think you might stick all the bits together.**

C I know that because Mum showed me with a gingerbread man. We made a gingerbread man and I watched her do it.

R **How did she make the shapes for that?**

C She just cutted … she just made the shapes with … she just drawed the shapes and then she cutted it out and sticked him on a piece of paper … stapled, and then she copied a man.

R **She copied a man?**

C She copied a man in a book … a man … gingerbread man … she read it in the book.

Kristy provides a similar example when discussing the same problem.

R **How do you think they might have got that little shape there (of the academic bear)?**

K Put it in a … get a thing that has shapes on them … like today when I … when Mummy did my sandwiches, she got a little container and

put it … and squished the sandwiches and they were stars …

R So … I think it's a little cutter that you're talking about. Can you show me how you do the cutting … if this was the chocolate, how would you use the cutter to make the shape … the Freddo Frog shape? How does Mummy use the container?

K Put it on the sandwich and stuck it down.

These examples illustrate two students' ability to apply prior knowledge and experience to a new episode; effectively transferring the knowledge they have gained at home in order to interpret the new experience of making chocolate. The other students were unable to make the same links either because of limited pre-school experiences or an inability to consider process, as opposed to merely naming materials and equipment.

5.4.3 Students' language development

A final theme to be investigated is students' language development, which is a key element in students' successful engagement with EOTC and technology education. Oral language plays a significant role in students' thinking and learning, and on-going development allows them to increasingly engage in discussions, ask questions, and refine their ability to listen and understand the spoken language of others.

Establishing the language development of the students participating in this study and determining the level at which they use language gives insight into the limits of detail and accuracy in their descriptions and allows us to gauge the 'next steps' in their learning. Findings related to evidence of student language development are presented here. These include students' use of language skills to express their feelings, to reason, to guess, and to express ideas of probability. Their ability to draw on personal experiences and knowledge when faced with unfamiliar situations was investigated, as was their use of topic-specific vocabulary and personal content words, which they may employ in order to express their ideas. Evidence of students asking a question was also noted.

All participating students were able to express in simple terms how they felt about the scheduled visit to Candyland, typically using vocabulary that demonstrated that they were feeling good, happy or excited. Providing a reason to support this proved more challenging and only eleven of the 16 students responded. Unsurprisingly seven students were excited because they expected to make chocolate or a lollipop, and, at best, would be able to eat them. Lyall and Isla offered other reasons for their enthusiasm. Lyall said. "It will be fun going in the car" and Isla was happy about going because "my mum's going to be helping next week". Of the remaining five students, two offered somewhat nebulous reasons, such as, "I'm excited about the candy" (Zoe, 1st interview), and "because it's going to be fun" (Clarke, 1st interview).

Guessing, as estimating or concluding (something) without sufficient information to be sure of being correct, can be a feature of five-year-old language (MoE, 1996). There was one example of this during the first interview when Dana, a novice reader, guessed at the text on a chocolate frog – it read "Freddo Frog" but as she had very limited graphophonic knowledge, she guessed at the text.

R Do you know what this is?

D It's chocolate.

R It is chocolate. Do you know what that says?

D Chocolate?

R Good try.

D Chocolate frog.

R Yes it is a chocolate frog isn't it … (pointing to the text) Freddo … it's called Freddo Frog.

It could also be interpreted as Dana using reasoning skills by offering "chocolate frog" as her answer in response to the frog-like shape of the chocolate. In the same way a novice reader uses illustrations and visual information to make sense of unfamiliar text.

Generally, students' responses to interview questions demonstrated their ability to reason – the ability to base their answers on existing knowledge and/or experiences, as opposed to guessing. I observed that the children were more likely to say they didn't know the answer to a question rather than take a wild guess, particularly Billy who was a recent immigrant from China. He frequently responded with "I don't know" and was not prepared to take risks if he was unsure of the answer.

More frequently noted language skills were those showing examples of prediction and probability. Prediction in the English curriculum refers to a student's ability to anticipate what might happen next or something that will happen in the future (Ministry of Education, 1996). In a reading context this is a term more akin to guessing, e.g. predicting what might happen next in a story, or predicting, by using the sentence structure of the text, what a word might be. Probability includes the use of words such as might, can't, always, never and sometimes (Ministry of Education, 1996) – words that indicate possibility but without certainty. Examples of this are seen in the following two quotes from Lizzie and Nick. In the first example, Lizzie is discussing her ideas about what she might see at the factory.

R Have you got some ideas about what you might see there?

L When they squash those things to make chocolate

R Oh, okay, so you mean the cocoa beans?

L Yeah, yeah. All the beans are squashed together.

R Already squashed together … okay …

L Probably they won't have the machine there.

Nick used similar language skills when he discussed how the academic bear was made if it couldn't be knitted.

R If the people couldn't do knitting, how do you think they might make it (the academic bear)?

N They might put stuffing in it and then sew it up.

In achieving technological outcomes at level one of the technology curriculum, students are expected to "communicate the outcome to be produced", "identify materials that technological products are made from", "describe what a functional model is" and so on (Ministry of Education, 2010b). Students' performance in this curriculum area is very dependent on their ability to communicate their ideas and having developed a vocabulary that allows them to do so. By identifying topic-specific words, which participants used to communicate their ideas and understandings, it is possible to establish the foundation upon which to build further knowledge and to better understand the limit of the students' responses – if a child doesn't have the words to express their ideas it is unlikely they will be able to fully communicate what they know.

The student interviews and drawings completed prior to the visit were analysed, resulting in a limited number of topic specific words, which the students included in their responses. These related to the names of materials, ingredients and everyday appliances (see Figure 5.9).

Of the 16 students who took part in the interviews, six students named materials such as cotton, sheep's wool, string, beans and fur when describing how the academic bear could be made, and, in total, there were 15 references made. Ten students suggested a range of commonly recognised ingredients when they described how they thought chocolate could be made, with an increased total of 36 ingredients specified.

Text:
Put the brown stuff in a bowl. Mix it up. Melt it in the microwave. Put butter in. Put flour in, then baking soda. Put it in the oven.

Figure 5.9 Dana's drawing showing how to make chocolate

Three students thought milk would be needed to make chocolate at the factory, Rosie expected to see coconuts and sugar used, Sean thought cocoa-beans would be important, and Mana listed cream, peanuts and sprinkles. Dana indicated some knowledge of the process involved and referred to melted chocolate in her interview. As can be seen in Figure 5.9, she also listed a range of ingredients, which she included in the text of her drawing.

Personal content words are those words that students would not normally include in their vocabulary but which are in common use within their families. Sean described knitting as a way of making the fabric academic bear, because he had seen his grand-mother knitting. Lizzie referred to "ingredients" on several occasions and how a recipe book could be used to find out how to make chocolate. She had often worked alongside her mother preparing a range of food products. Lizzie surprised us with the suggestion that a "template" (her word) could be used to make the shape of the little bear – again an experience she had shared with her mother.

In my experience as a teacher of new entrants, students substituting conventional language with similar known vocabulary, indicates a readiness and interest in acquiring more advanced language. Gathering this information at the beginning of a teaching block acts as a diagnostic tool and gives direction to the next teaching steps. In this study it provides base-line data, which can be tracked during each phase of the teaching, and allow an examination of an improved use of topic-specific vocabulary as substituted language diminishes.

In the first interviews prior to the visit, five students resorted to the use of substitutions in place of unfamiliar nouns. They generally used words such as "things" and "stuff" in an attempt to communicate their ideas. Dana was particularly adept at this strategy as she described how the academic bear might be made.

R And tell me how you think the people might make that little bear?

D Umm.

R What would they need to do?

D Get some fluff.

R Some fluff … okay, they need to get some fluff.

D And put the fluff inside and then put the fluffy stuff in it.

R Which fluffy stuff do you mean?

D The fluff … the brown stuff.

R The brown stuff, so this stuff here?

D Yeah.

R **Okay.**

D And pink stuff … pink.

Five other students used “things” or “thingies” to describe various items – “a shape thing” (referring to a cutter), “the special-est things” (the chocolate display at the factory), “eye thingies” (small plastic eyes on the academic bear), “a hook thing” (the hook-shaped stretching machine at the factory), and "some things” (fabric glue to attach eyes onto the bear). Kristy made a syntax error when she discussed a DVD she had, though appeared to correct it: “It was a borrow from – it was a DVD from my friend Max and a little boy ate too much chocolate”. Kris used four incorrect past tense irregular verbs – rotteded, drawed, cutted, and sticked instead of rotted, drew, cut and stuck – whereas the remaining students generally used language that was simple in structure but grammatically correct.

Knowing how to ask a question allows students to probe and investigate contexts and to clarify their thinking. Three students asked questions during their interviews, and each question was initiated by a topic which was of particular interest to them. Kris launched into an extensive and somewhat amusing discussion about chocolate and teeth decay when I asked him to tell me about the new things he might learn on the trip. The example below is also typical of the slang and shortened words used by this age-group.

R **Do you think you might learn anything new when you go on the trip?**

C Yes, and it’s not to eat candy ‘cos it rots your teeth.

R **Yes, it does if you eat a whole lot of it, doesn’t it … if you don’t clean your teeth really well. Who told you that?**

C My dad, ‘cos he’s (got) rotteded teeth, now he needs some false teeth.

R **Oh, no … well Dad’s right, isn’t he … it’s okay to have just a little bit.**

C It’s only ‘cos he was in the olden days and he didn’t have a toothbrush.

R **Didn’t he? That was terrible, wasn’t it?**

C And I wasn’t in the olden days.

R **Lucky you weren’t in the olden days.**

C Do you know why dad gets some yucky teeth?

R No.

C 'Cos he eats oodles of chips and salt […?].

R Is that what Mum said?

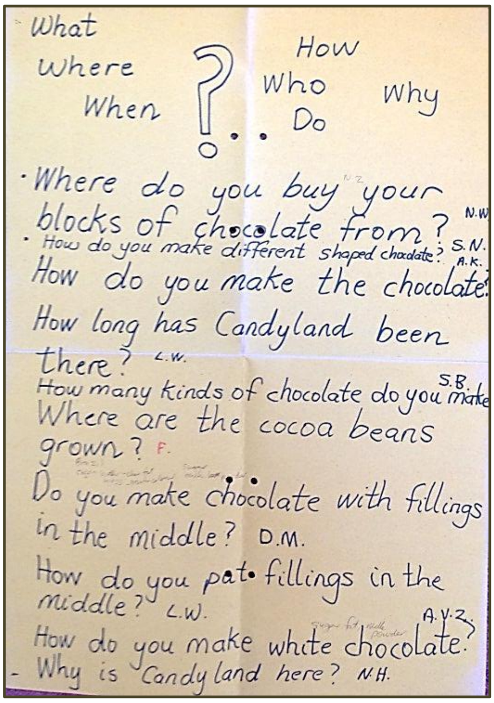
C Mmm … he eats snakes.

R Snakes … oooh … not real snakes I hope … jelly snakes.

C No … candy snakes.

Two other students asked a question during the interview - Rosie was keen to know whether she would be able to make a lollipop when she went to Candyland and Olivia wondered if I had the chance to make some chocolate when I went on my pre-visit to the factory.

Being a confident user of language, being able to ask questions, clarify thinking and challenge existing assumptions and perceptions together can help develop students who are competent thinkers and problem-solvers (Ministry of Education, 2007b) – characteristics which are crucial to design and technology. Further extension of these skills can enable students to increasingly make sense of, and apply, the new knowledge gained during a learning experience outside the classroom.



Text: (What, where, when, how, who, do, why questions)

- *Where do you buy your blocks of chocolate from? (Olivia)*
- *How do you make different shaped chocolate? (Sean)*
- *How do you make the chocolate? (Andrew)*
- *How long has Candyland been there? (Lizzie)*
- *How many kinds of chocolate do you make? (Sean)*
- *Where are the cocoa beans grown?*
- *Do you make chocolate with fillings in the middle? (Dana)*
- *How do you put fillings in the middle? (Lizzie)*
- *How do you make white chocolate?*
- *Why is Candyland here? (Nick)*
- *Where do the cocoa trees grow? (On the back of the chart)*

Figure 5.10 Teacher chart recording student questions

At this point in the first phase of analysis, there is an indication that students had a limited use of context specific vocabulary, but several students demonstrate a willingness to express their ideas through the use of substitutions (things, stuff, amongst others). Their interest and enthusiasm was clearly evident and they could now potentially benefit from opportunities to become more familiar with the finer detail of the chocolate-making context.

A task included in the intervention required students to identify questions that they could ask the presenter at Candyland. This was intended to steer the 'need to know' element of the visit. As can be seen in Figure 5.10, Oldpark students worked with their teacher to assemble a list of questions. Although it was intended that the students would present the questions themselves, when the time came, they lacked sufficient confidence and their teacher asked the questions on their behalf.

During the interviews prior to the visit, when students were asked to describe questions they would ask, or describe things they wanted to find out at Candyland, there was a mixed and limited response. Only two students correctly structured a question. Kristy said she would ask how they made chocolate at the factory, and Nick said he would ask whether they used sugar for the chocolate. Neither of these questions was included on the classroom chart but each was a relevant question to ask. Dana seemed unsure about the concept of a question in this context and provided the following remarks.

R **Are there any questions that you might want to ask the people out there?**

D We need some … machines to make it.

L **Okay, but is there anything that you will need to ask the people about making chocolate?**

D I don't know.

In the classroom, with teacher support, she posed a question about chocolate fillings, "Do you make chocolate with fillings in the middle?" (Dana, lesson before the visit). Other students tended to make statements about what they would find out at Candyland rather than the questions they would ask. This was unexpected as they could competently ask questions relating to their daily lives –

asking for help, asking for equipment in the classroom, asking where a friend had gone. The concept of gathering information to support their technological practice through questioning was a skill that still required the support of their teacher. This accurately reflects Vygotsky's notion of the zone of proximal development in that there is an interaction between the children and adults of unequal expertise which then provides the opportunity for the internalisation by the children of a transformed version of the communication, and resulting in their emerging ability to think and act independently (Nuthall, 1997, 2007).

As stated by McNaughton (2002) the students' ability to engage with oral language, as the principal medium of teaching, will be "significantly influenced by their pre-school knowledge and experiences" (p20). It would seem, therefore, that in this study, the five-year-old students' oral language prior to the EOTC visit generally incorporated a limited used of topic-specific language, a reliance on substitutions to express their ideas and some use of personal content language.

5.4.4 Summary of the characteristics of the five year olds

In summary, it was evident the teacher reflection on past EOTC experiences was useful in the process of planning and managing a visit for very young school-aged students. Student interest and willingness to engage in all facets of the visit is crucial but this is influenced by the site selection, students' level of oral language development and their ability to absorb and transfer understandings to a new and different episode.

Students' oral language skills are influenced by the socio-cultural contexts from which they come and the prior knowledge and experience, which has been formed during their early childhood years. The students in this study brought diverse knowledge and practical use of literacy skills, particularly oral language skills. They had a limited use of topic-specific vocabulary, and, though they were willing to substitute language in order to communicate their ideas, they required support in formulating their ideas and questions within a context about which they appeared to have only partial knowledge.

The data from this study included some examples of students transferring knowledge from experiences they had had at home and applying to them to the processes involved in making chocolate and constructing the academic bear. This confirms the potential of learning experiences such as those that can be provided through EOTC for five-year-old students. It also indicates the possibility of applying their understanding and the new knowledge gained at Candyland to their own technological practice, i.e. making chocolate for Mothers' Day, which is discussed in Chapter 6.

5.4.5 Chapter summary

This chapter has described the analysis of the first phase of data which was gathered prior to the students and their teachers going on a visit to Candyland. The purpose of the visit was to gather information about chocolate making which the students would use to design and make a chocolate gift for Mothers' Day. The chapter described three areas of investigation; technology education, learning experiences outside the classroom and the characteristics of five-year-olds.

Data which described students' existing understandings were generated through individual interviews, and the analysis of a range of documents prepared by the students and the teachers – drawings to describe a chocolate they had examined, a dictated story and drawing to describe how chocolate might be made, and a list of questions to ask presenters at Candyland. Data obtained during a planning meeting between myself and the two teachers was used to cross-check evidence provided during the interviews and document analysis.

By careful selection of a context and meticulous planning, enthusiastic engagement was achieved by all participants. High levels of interest were generated, and those who visited Candyland with an understanding of the purpose of the visit, should be well positioned to carry out a simple process of information gathering to help them design and construct their chocolate gift for Mothers' Day.

The teachers interpreted the teaching plan according to the needs of their students and this resulted in some elements of the plan being highlighted, some receiving a cursory examination and others being over-looked. This appears to have brought about differences in the preparation of each class with some students being uncertain why they were visiting Candyland and others having a clear understanding that this was to be an information gathering exercise. At this point it was unknown whether this was to have an impact on their product development.

The students' knowledge of materials and material properties was limited before the visit, particularly those required in the chocolate-making process. Most were more familiar with everyday food products and could name several ingredients which they thought might be used in chocolate making. There was generally little concept of process and the steps required to create a product, although some students were able to draw on prior experiences in which they had made food products or had seen knitted toys made at home. Prompting during the interviews revealed knowledge of a two or three step process.

Throughout the interviews it was clear that where students had insufficient language to express their ideas, the information they had to share was naturally restricted. Students with high levels of personal content words were advantaged. Vocabulary which was specific to the context of chocolate making was generally limited but several students were prepared to use approximations or substitutions in order to express their ideas. When faced with questions they didn't know the answer to, they showed good reasoning skills and some students confidently predicted events or outcomes to be achieved in the future.

In the following chapter, findings derived from the data gathered during and directly after the visit to Candyland are presented.

Chapter 6

Findings 2: Organisation and development during and after the visit

6.1 Introduction

Chapter 6 introduces the second phase of this study, which focuses on the organisation and preparation of students and parent-helpers during the visit to Candyland, and the activities which occurred directly after the visit. The technological problem of how to make a chocolate gift for Mothers' Day had now been well-established, and students' focus on this was to be continued throughout this second phase.

As in the previous chapter, the analysis of data has been organised into three areas, Technology Education, Learning Experiences Outside the Classroom (EOTC) and Characteristics of Five-year-olds. There were 16 participating students and two teachers.

The role of the parent helpers, and the impact this had on student learning is also investigated in this chapter. Six parents from Dayton School and seven from Oldpark School assisted during the visit, with an additional four parents from each school who helped students create their chocolate gifts in the classroom after the visit. The parent helpers from Dayton School who attended the factory visit were different from those who came to help during the gift-making session at the school, whereas the majority of those from Oldpark assisted during both the visit and the chocolate-making afterwards.

Managing the visit to Candyland required several meetings, firstly with the staff at Candyland and then with the groups of parents who volunteered their help with transport to and from the factory and with supporting and supervising the students during the visit. The meeting with staff at Candyland provided an opportunity to explain the purpose of the research, the teaching goals, the age-group of the participants and finally to negotiate a change to their usual public presentation.

The normal chocolate-making presentation was typically quite short with further detail and activities being provided during the lollipop-making demonstration. It was negotiated with the presenter that the chocolate-making presentation would be extended for our visit, and would include more about the factory's source of chocolate, detail of the equipment and additives used to create coloured and filled chocolates, and, as with the lollipop presentation, an opportunity for the students to make a chocolate product (see Figure 6.1).

Figure 6.1 A Candyland presenter introducing chocolate-making

Preparing the parent-helpers to carry out their role was seen as critical to the success of the visit, and the rationale behind the decisions made regarding that role, was guided by the EOTC literature. This not only considered the learning needs of the students but also the engagement and commitment of the parents when carrying out their responsibilities. This was to be more than the usual supervisory role. Accordingly, each parent received information explaining the purpose of the research project, a formal request for their permission to be part of the research, an outline of the learning intentions of the teaching unit, and suggestions for carrying out their responsibility as a parent-helper (see Appendix B for further details.) An effort was made to communicate the importance of their role and to emphasise their responsibility for drawing students' attention to the exhibits, the chocolate displays, the moulds, fillings, colourings and equipment – items which five-year-old students may overlook. Parents were encouraged to use language associated with chocolate-making and to simplify any aspects of the presentation that they considered too difficult for the students to understand. Meanwhile, the teachers, Rose and Hannah, were encouraged to maintain an over-view of the whole group – the parent-helpers, factory staff and students, and to take every available opportunity to photograph the stages of the visit. These photographs were to be a key part of the follow-up activities once everyone had returned to their respective schools as well contributing an important element to the data set.

The data presented in the following sections were gathered in a number of ways. This included individual interviews with all 16 students directly after the visit. In addition, students' drawings about chocolate-making, reflecting their visit to the factory, and the modelling and construction of their chocolate gift were also considered and analysed. The student work was colour copied if the originals were not able to be collected, and photographs were taken of the models and gifts.

The photographic record that was gathered during the visit to Candyland was continued throughout the design and construction phase of the teaching unit. Field notes were compiled which recorded my personal observations of students, parents and staff throughout this phase. After returning to school from the visit, two parents volunteered to be interviewed and this offer was accepted. An interview with each of the teachers, Rose and Hannah during which they reflected on the planning process and the outcomes of the visit completed the data set gathered for this phase of the research.

6.2 Technology Education

As in the previous chapter, this area of analysis is investigated under the four headings of conceptual, procedural, technical and societal knowledge. These headings, based on a framework of analysis from the LITE project (Moreland, Jones, & Chambers, 2000) are broken down further into the themes identified in Table 6.1 and provide the structure for the ensuing discussion.

6.2.1 Students' conceptual knowledge

In this section, findings related to evidence of student conceptual knowledge are presented. Students' knowledge of chocolate and chocolate-making is described along with their knowledge of the purpose and application of modelling. Materials, material properties and how these may be combined are also considered. The analysis of these themes illustrates the impact the visit to Candyland had on their knowledge of product development and, in particular, of chocolate and chocolate-making.

Table 6.1 Student familiarity and engagement with the context of chocolate and chocolate-making

Themes of data analysis	
Conceptual knowledge	*Students' ability to:* • Demonstrate a familiarity and engagement with the context of chocolate and chocolate-making • explain the purpose of modelling • name a range of materials and recognise each one has particular properties • recognise that a series of steps is required to create a product • describe a simple concept of technology
Procedural knowledge	• describe in sequence how a nominated product is made • apply survey data to the design of the final outcome • construct models that take into account feedback from the consumer • consider changes or improvements to the final outcome
Technical knowledge	• identify and name equipment required to make chocolates • recognise ingredients are heated/cooled in order to create a product
Societal knowledge	• ability to recognise the product consumer as being other than him/herself

6.2.1.1 Student familiarity and engagement with the context of chocolate and chocolate-making

This theme was considered in terms of the students' abilities to discuss and describe chocolate and chocolate-making, and their motivation to engage with the activities offered as part of the Candyland experience. At the time of the visit, students had been extensively prepared, and, although elements of their preparation were presented with an emphasis which differed between the two teachers, the students had a beginning knowledge of the origins of chocolate, sourcing the cacao bean, and how chocolate was made. The idea of making a chocolate gift for Mothers' Day and, as a consequence, the need for information to achieve this, had also been presented.

There was consistency between students' mention of chocolate in their interview after the visit and their chocolate-making experiences during the visit. All 16 students from Dayton and Oldpark schools were asked questions that invited them to think about the chocolate displays and presentations they had seen in the Candyland retail area, for example: "What was the very best part of the trip?" or "What did they (the presenters) do first?" and "What sorts of things did you look at in the shop?" A typical response was given by Dana who thought that eating the chocolate was the best part of the trip, and Kristy spoke confidently about the presenters: "They talked about the chocolate, the big block of chocolate" (see Figure 6.2). Lewis had good recall of the shop display and said: "I saw um chocolate marsh-mallows, fish, um … those little chocolate raisins, chocolate and those ones with all sorts of colours".

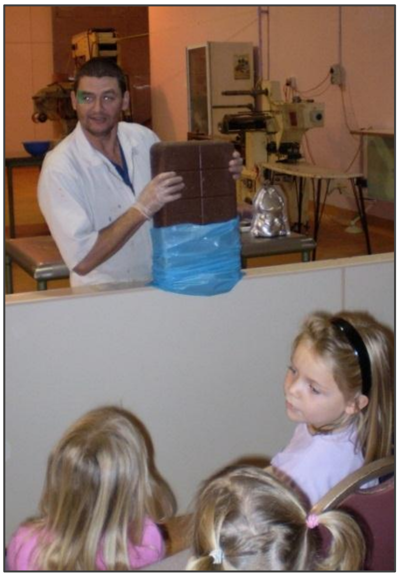


Figure 6.2 The presenter introducing the bulk chocolate used at the factory

Figure 6.3 The presenter assisting students to make a chocolate fish

The drawings and stories created by the students provided some interesting insights. Students from Oldpark School were asked to describe how they made the chocolate fish at Candyland. All eight students were able to draw a series of pictures which accurately described the process they had participated in with the factory staff, Lance and John. The students referred to the big block of chocolate, the cooling machine (the cooling tunnel), the fish moulds, the melted chocolate and the 'waterfall' of melted chocolate (see Figure 6.3). Figure 6.4 shows an example of this task in which Kristy drew her sequence of pictures and then dictated the captions to her teacher.

Dayton students were provided with several opportunities to draw and write about their experiences at Candyland. Their daily writing tasks focused on the taste-testing activity, followed by the visit to Candyland and finally, the results of their questionnaire – what type of chocolate Mum likes.

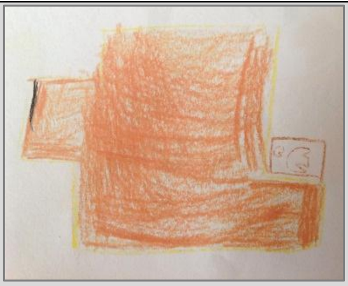
Drawing No 1	Drawing No 2	Drawing No 3
		
Here is Lance and he is holding the big block of chocolate and he is talking about it.	This is the bowl. The big block of chocolate is in the bowl.	This is the cooling machine and the fish are going into it to be cooled down.
They have to be hard to eat so you don’t get chocolate on your fingers.”		

Figure 6.4 Kristy’s sequence of captioned drawings showing how the presenter helped the students make a chocolate fish.

Of the seven students who wrote about the visit, all referred to making the lollipop. There was no mention of making the chocolate fish. Isla wrote - “We went to Candyland. I saw Lance stretching the candy lollipop on the hook.” In a similar vein, Kris and five other students wrote, “I went to Candyland and I made a lollipop”.

The colourful pen and wash drawings that the Dayton students created, (see Figure 6.5) also focussed entirely on making the lollipop with only one exception - Clarke who dictated the following story to his teacher:

> My Mum took us to Candyland. The man showed us how to make a chocolate fish. Then I made a lollipop. I rolled up the candy just like a snail. Then I put a stick in it (Clarke, drawing after the visit).

The six remaining students from Dayton School wrote detailed stories that described how they made their lollipops. Isla’s story was typical of those written by her class-mates: “At Candyland I made a big lollipop. Lance gave us a piece of stripy candy and we twisted it. Then we curled it into a circle, and then we put a stick into it” (Isla, second drawing).

In summary, when students were specifically requested to draw and write about their chocolate-making experience at Candyland by their teacher, they were able to construct detailed and accurate descriptions.

Figure 6.5 Student drawing showing a chocolate-fish making activity

However, when the students were offered less direction, for example the students from Dayton School, they drew pictures and wrote about the lollipop making presentation which was the final task they participated in before returning to school. The chocolate-making presentation and activity appeared to have mostly slipped from their focus. The timing of these activities therefore, became an issue when attempting to identify the students' understandings of making chocolates rather than making lollipops.

Students' understanding of the purpose of modelling

The students in this study were asked to create a three-dimensional model out of play dough or modelling clay to help them explore the shape and size for their gift. Figure 6.6 shows four examples of the Oldpark students' clay models. There was no compulsion to replicate the shape when it was time to create their chocolate gift, but the task was intended to give an opportunity to think about and discuss their ideas about appropriate designs.

Figure 6.6 Students' clay models of their chocolate gift

The student interviews after the visit included a question that asked students why they had been asked to make a model of their chocolate gift. Two students were unwell during this time and were unable to participate.

Eleven of the remaining 14 students were able to offer an explanation, and 13 of the students provided a reasonable interpretation of the task. Five students referred to the models helping them decide the shape of their chocolate gift. Isla said, “Because that might be the shape you want to make”, and Rosie thought “So we know how to make the shape of the chocolate”. Other comments suggested the models would help the students to be ready when the parents came to help them make their chocolates. Billy said, “So when the mums come, we can do it”. Sean was a little puzzled about the reason for making clay models and felt his teacher had misguided the students. He said: “’Cause she thought we would make chocolate out of it (modelling clay), but we didn’t, and then we made chocolate like other chocolate”. The three boys who were unable to offer an explanation, two from Dayton School and one from Oldpark, said they had either forgotten or they were not sure why they modelled the chocolates. In total, 11 of the 14 students appeared to understand that the modelling task was purposeful and, in some way, informed their chocolate-making task. The ideas were simplistic but the students’ responses suggested they were beginning to see the interconnectedness of each stage of the process they were working through in order to create their chocolate gift.

6.2.1.2 Students’ knowledge of materials and their properties and students understanding of the steps required to create a product

In Chapter 5, reference was made to the work of Frederik, Sonneveld and de Vries (2012) which argues that students’ abilities to relate the properties of materials to their potential use in a technological development is a key element of successful technological practice. This section, therefore, examines the materials that students recognised during their interviews and are referred to in their stories and drawings. Whilst the interview questions did not specifically ask students to name materials, they were asked to describe how a range of products might be made. In this interview, as shown in Figure 6.7, the products were a three-dimensional jigsaw in the shape of a wooden dinosaur and a small bear-shaped chocolate biscuit, with the trade name of ‘Tiny Teddie’.

Figure 6.7 The wooden dinosaur and Tiny Teddie chocolate biscuits

Data that illustrates students' knowledge of materials during this second phase of the research was again gathered from a total of 16 interviews, along with 15 drawings with dictated captions, and seven sets of stories written by the Dayton School students. Throughout this data, there was little attempt by the students to describe how chocolate was made, but rather it was referred to as an ingredient to be used when making chocolate products. When describing how the chocolate biscuit was made, five students made suggestions such as this example reported by Kris: "They put chocolate and then they would have put it in the mould and poured chocolate onto it and then carefully pulled it out." In a similar vein, Kristy's response was, "Um they'd get some mix and put it in. And when it's dry and hard, they'd put the chocolate on". These examples indicate students' developing ability to connect the materials of the product with the process of creating the product. It also indicates students' awareness of the changing state of materials or ingredients used in creating a food product – in essence the change from liquid to solid. This is in contrast to the examples in Section 5.2.1 where students' focus was primarily on the raw materials used to make the product.

The students' descriptions of how the wooden dinosaur was made revealed some interesting developments in their understandings. Twelve of the 16 students were able to name wood as the material from which the dinosaur was made, and seven of these students referred to the wood being either coloured or needing to be painted. In contrast, Lyall believed the dinosaur was made out of metal. Six boys from both Dayton and Oldpark Schools suggested using a chainsaw or a knife to cut or shape the wood, and surprisingly, six students appeared to incorrectly link their new chocolate-making knowledge to making the dinosaur. Clarke offered this explanation:

R **How do you think you would make this dinosaur?**

C Get some chocolate and pour it into a dinosaur mould.

R **Ok.**

C There doesn't, it's not […].

R **It's not what?**

C It doesn't feel like chocolate.

R **No, no.**

C It's made out of wood.

R **It's made out of wood, good boy. So how do you think it's been made then?**

C Colourful wood being cut up…

R **Yes.**

C And they've changed all the, cut the wood out for the spikes.

Billy also demonstrated a connection with making the chocolate fish at Candyland.

R **What would they have to do to make it (the dinosaur)?**

B Um put it in a mould.

R **Put it in a mould? Ok. Which part would they put in a mould?**

B Um they would put it in a dinosaur mould.

R **They'd put it in a dinosaur mould. Ok. And tell me some more, what else would they have to do?**

B Um they'd have to make it cold so it could be hardened.

Several other students suggested "making the wood first", using a mould to create the dinosaur shape, and Nick thought you would need a machine to make the "special material" (the wood) hard. It seems that the students now had a firm grasp of the chocolate-making process, i.e. melting the bulk chocolate, using moulds to create the shapes and cooling the final products in order to harden them. In thinking about the wooden dinosaur, several of the students attempted to apply the same understandings to its construction. The children were well-acquainted with wood as a construction material, but its performance properties and how it could be manipulated and converted into a final product, was not well understood. Conceptually all 16 students indicated an understanding of product development requiring a series of steps but, as in the previous chapter, this was constrained by their limited knowledge of materials and material properties.

6.2.1.5 Students' concept of technology

This study presented an opportunity to gather data that illustrated the students' views of technology – what technology is and how it might be defined. This data was gathered by using the two charts shown in Figure 6.8. as the focal point for discussions.

Figure 6.8 Interview charts for discussion "What is technology?"

The results ranged from no understanding at all through to the simple but accurate description of technology from Billy.

R **Can you tell me the things that you think might be to do with technology**

B Um aeroplane.

R **The aeroplane, good boy.**

B The earphones. That one.

R **Right, the MP3.**

B The watch. [pause] The light.

R **You think the light? Good thinking. Anything else there? Ok, what about the ice cream, would that be to do with technology? No? Why not?**

B I don’t know.

R You don’t know? You just don’t think it is. What about the bird? Is that to do with technology? Why wouldn’t it be to do with technology do you think?

B Because um the duck can lay eggs and it can […] it can break.

R It can break.

B And ‘cause some baby chicks came out.

R What about this picture of the flower, is that to do with technology?

B No you can plant it and it can grow by itself.

R Good boy, thank you. So what is it about all these things, and you’re quite right, they are all to do with technology, what is it that makes them all to do with technology?

B (You) can make it.

Four students were able to select technological items from the charts but were unable to explain why they had chosen them. Three students said they had heard of technology. For example, Dana explained that a student teacher had told them about technology but she could not remember what was said. Clarke had “never heard of it before” but thought “God and Jesus might have something to do with it”, although he later changed his mind and thought God probably would not have made my pen – he said, “someone made that but not Jesus or God”. Despite this lack of clarity around defining technology, seven of these students offered sound reasons for creating or building the items on the interview charts. In response to my question, “Why do you think people have made these things”, Sean thought it was to help people, Isla said it was “because you need them – something you can use”, and Kayne identified some items which were technology, i.e. clothing and my pen, and explained why we needed each of them: He explained “so we don’t get cold”, and “so you could write something”. Clarke aptly summed up the need for all the items by stating, “we need all this stuff!” Overall there was a mixed response, but a clear indication that the students had, perhaps unconsciously, developed novice understandings of what constituted an item of technology, and how these could be categorised.

6.2.1.6 Section summary of students' conceptual knowledge

In this section there was evidence that students' had made significant conceptual knowledge development of chocolate and chocolate-making since the initial interview before the visit to Candyland. Their enthusiastic engagement with this context was consistent across both classes of students, and whilst their knowledge of material properties was limited, their descriptions of making chocolate demonstrated greater understanding and contained increased levels of detail. Students were able to describe the purpose of creating models prior to making their final product, but their awareness of technology as a way of categorising the world around them, indicated a very narrow and incomplete view. The students' ability to draw on these understandings in a practical sense is described in Section 6.2.2.

6.2.2 Students' procedural knowledge

As described in Chapter 5, procedural knowledge refers to students' understanding of the process and sequence of tasks that is required to develop a product. In this section, evidence of students' procedural knowledge gathered during the second phase of data collection is presented. Students' abilities to describe the stages of product development were analysed, along with their understanding of the purpose and use of modelling within their technological practice. Appreciating the factory as a potential site for learning is considered, as is students' abilities to discuss changes or improvements they would like to make to their chocolate gift, i.e. their ability to evaluate their final outcomes. The analysis of these themes continue to illustrate the impact of the visit to Candyland on students' knowledge of chocolate and chocolate-making, as well as the transferability of these new understandings when they attempt to describe how the wooden dinosaur and the Tiny Teddie chocolate biscuit had been made (see Figure 6.7 above).

6.2.2.1 Students' description of the steps and sequence to make a product

In order to identify students' understanding of technological practice, interview questions focussed on how they thought the three-dimensional wooden dinosaur and the chocolate biscuit were made, as well as reflecting on how they made their chocolate fish at Candyland and their Mothers' Day gift when they returned to school. In addition to the interviews, Oldpark students were asked to draw a sequence of three pictures that described how the presenters at Candyland helped them make the chocolate fish. Their teacher, Rose, gave them a piece of A4 paper, folded into three sections. She asked them to draw a picture of something that happened at the beginning of the chocolate-making process, something that happened in the middle, and something that happened at the end of the process. Once completed, the students dictated captions which the teacher and I wrote underneath each drawing. Rose and I prompted the students to describe their drawings with a simple request – “tell me about your drawing”.

Hannah provided a slightly different task for her students on their return from Candyland**.** She asked them to draw a picture of something they did during their visit to Candyland. Once completed, they dictated a story about their drawing to the teacher aide who typed each one up, printed it out, and then displayed the drawings and stories on the inside wall of the classroom.

The students’ abilities to sequence simple tasks were established in the interview before the visit and this pattern was maintained during this second phase of interviews and data collection after the visit. Invariably, the Oldpark students were able to identify how you would begin making a product in their sequence of drawings describing how they made a chocolate fish at Candyland.

Student drawing No 1	**Student drawing No 2**	**Student drawing No 3**
		
Lance showed the big block of chocolate.	Lance showed us the big cooling machine. The chocolate came down like a waterfall.	He showed us how to put the chocolate into plastic moulds.

Figure 6.9 Nick’s drawings showing how the chocolate fish was made

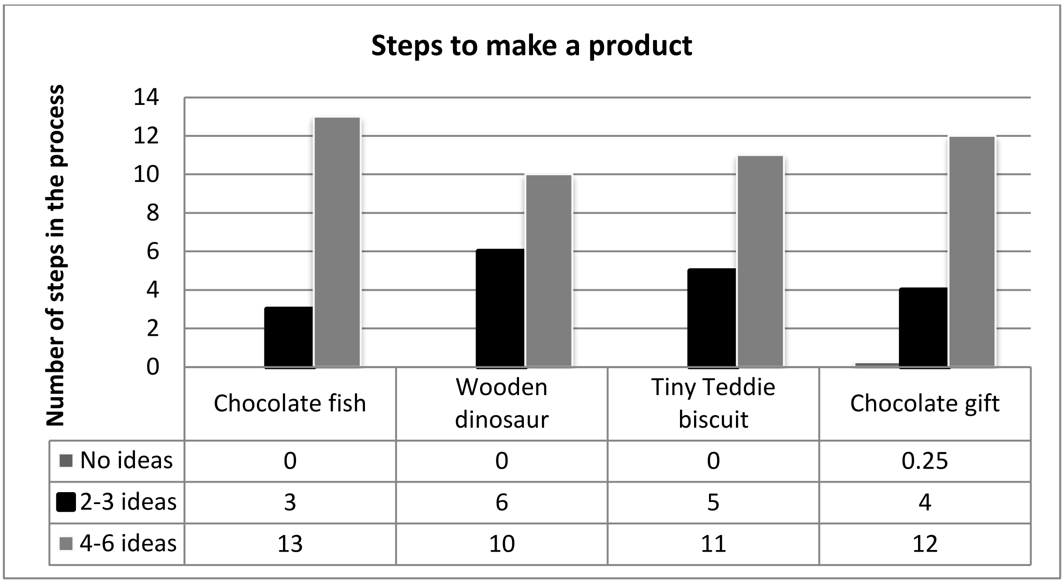
For example, they all referred to Lance holding or showing the big block of chocolate in their first drawing. Kristy described her first drawing in this way: “Here is Lance and he is holding the big block of chocolate and he is talking about it". Rosie said, "Lance is holding the big block of chocolate. He doesn't sell them. He cuts pieces off". Seven of the eight students from Oldpark also referred to the chocolate fish in their final sequence of drawings, making statements such as "I'm putting the chocolate in the special fridge (Lizzie, final drawings). We made chocolate fish" (Olivia, final drawings) and, "The fish went into the cooling machine. It made the fish go hard" (Dana, final drawings). Nick, while providing an accurate sequence of drawings, continued to provide detail of the process in his third drawing, rather than offering a conclusion. His final caption read, "He showed us how to put the chocolate into plastic moulds" (see Figure 6.9).

An examination of the pen and wash drawings and captions from the Dayton students confirmed the capability of these five-year-old students to record and retell events in a logical sequence. Mana dictated his recollection of making a lollipop at Candyland:

> I went to Candyland. I got to make a lollipop. The man put some candy mixture into a chine (sic) to roll it out. He put some stripes on it. I twisted my piece and turned it around and I put a stick in it. Then I put it in a bag to take home (Mana, drawing after the visit).

In order to identify students' understanding of technological practice, interview questions were based on two items, a small bear shaped chocolate biscuit and a wooden dinosaur. Students were asked to describe how they thought these items were made. In addition, the students were asked to describe how they made their chocolate fish at Candyland, and how they made their Mothers' Day gift. As in the choice of discussion items in Chapter 5, the selection of the chocolate biscuit and wooden dinosaur was deliberate - the wooden dinosaur was intended to elicit students' ideas about the construction of an item not related to food or chocolate-making, offering a challenge for them to consider a context that they were less familiar with. In contrast, the chocolate biscuit was intended to provide students with a similar context but one that required some additional steps to complete its production. The construction of the chocolate fish and the Mothers' Day gift required the students to retell a personal experience which would illustrate their recollections, understandings, and interpretations of each episode.

Figure 6.10 summarises the students' descriptions of the steps required to make each of the items listed above. These are categorised as having no ideas, having two to three ideas, or having four to six ideas.



	Chocolate fish	Wooden dinosaur	Tiny Teddie biscuit	Chocolate gift
No ideas	0	0	0	0.25
2-3 ideas	3	6	5	4
4-6 ideas	13	10	11	12

Figure 6.10 Students' ideas of the steps required to make a product

The analysis of data indicated that all 16 students were able to describe a simple process by which the products listed in Figure 6.10 could have been constructed. Unlike the results of the interview before the visit to Candyland (see Section 5.2.2), all students were able to answer the questions in this section when they were asked to describe how the products were made. Descriptions of how the wooden dinosaur was made provided the greatest challenge with 6 students describing two to three steps of an incomplete and sometimes incorrect process, and 10 students were able to describe four or more steps of construction – again with less accuracy than the descriptions provided for other items. Frequently, as described in Section 6.2.1, aspects of the process observed in making chocolates, were transferred uncritically to manipulating wood and building the dinosaur jig-saw. Lyall explained his thinking:

R **What would they do to make the dinosaur? You have a feel of it.**

L Make the wood.

R **Yes, good boy.**

L And some, make the wood then make some colour on it.

R **Good boy.**

L And oh so they paint it on the wood.

R **They've painted the wood, yes you're right, yes.**

L And then, and then they cut it in half and they've breaked it up. And then and they've cut those bits and there and this one too, and they make little breaky stuff and you can take it off and you can make it back.

R **You can make it back, it's just like a jigsaw isn't it?**

L Mmm.

R **Good boy, good thinking. How do you think they would have cut that? What would they cut it with, do you think?**

L Um with a really hard saw and cut it really good (Lyall, interview after visit).

Isla was less descriptive but a little more accurate in her description:

R **Can you tell me how you think that *(*the wooden dinosaur*)* might have been made?**

I It might have been made by hard wood and then they painted it a colour and then they made it into shapes.

R **Good girl, good thinking. How do you think they might make all those shapes?**

I By some um by cutting some ends off (Isla, interview after visit).

The students' descriptions of how the chocolate biscuit might be made yielded greater accuracy, and more detail than was noted in the interviews before the visit. All 16 students were able to describe a series of at least three steps to make the biscuit, and 11 students provided further detail, between four to six steps. These descriptions were generally logical and appeared to draw on the prior knowledge students had accrued at home, in their early childhood centres, as well as during their visit to Candyland. For example, Billy said:

R **How do you think people at the factory might have made that little bear?**

B Um find cocoa beans.

R **Find some cocoa beans, good thinking.**

B Get some sugar…

R **Right.**

B …and milk.

R **Good boy. Ok, and what might they do then?**

B Um mix it.

R **And when they've mixed it up what do you think they'd do with it then to make that little bear shape?**

B Turn it into a mould.

R **Right, and what else?**

B I forgot.

A curious comment made by Lyall suggested the people at the factory made the biscuits, "Cause they've got nothing else to do but eating chocolate". His reasoning behind this was not clear but may link with observing the staff at Candyland making the chocolate fish and the lollipop, as opposed to carrying out other job-related tasks. Analysis of the interview transcripts indicated students were now more aware of process and less likely to only describe ingredients or materials. When students were actively involved in making the Mothers' Day gift, as shown in Figure 6.10, all 16 were able to provide a minimum of three steps to make each product, and 12 students could now provide additional detail, always in sequence, and often with a logical starting and finishing point.

For example, Andrew describes the process he observed at Candyland when he helped make the little chocolate fish:

R **Can you tell me all the things that Lance and John did to make the chocolate fish?**

A They get the special machine to melt the chocolate.

R **Yes, good boy.**

A And then I put it in the mould…

R **Yes.**

A …and after that they put it in a special freezer.

R **Special freezer. Ok. What did they do that for?**

A To make it hard.

R **What happened to the chocolates after they went into the special freezer?**

A They put it in the plastic bag.

Some students were able to provide additional detail, for example Mana, when describing how the chocolate was put into the moulds said, “We scooped some chocolate out and then we put it in (the mould)”. He also referred to “this circle machine … like a ball”, rather than referring to the generic ‘machine’.

The students’ descriptions of how they made their chocolate gift for Mothers’ Day indicated a similar level of understanding and detail. Isla provided this accurate description of how she made her gift.

R **Can you tell me all the things you had to do in order to make Mum’s chocolate?**

I You have, you have to spoon it into the mould.

R **Yes you did.**

I And you have to um, put it in, then they, and then how they made the chocolate, they had chocolate and then they melted it in the microwave.

R **Yes, good girl. Exactly right. And then what happened after you got the chocolate into the moulds?**

I Um, they then cooled down and then they started to go hard.

R **Yes they did.**

I And then they um, and then they, we put them in bags with ribbons on the top.

Lyall was a little more graphic in his description and said:

> Um we had to put one of those fish shapes and we, we’re going to put some chocolate in there and then make it. And you put it somewhere in the freezer, and you have to check it again. But if it looks like that slimy stuff you have to still put it in there, but when it gets hard, you can take it out and eat it (Lyall, 2nd interview).

> After the visit to Candyland and the experience of making a Mothers' Day gift, students appeared to be more conscious of technological process and less inclined to offer ingredients or materials as a way of making a product.

Attempts by the students to describe how unfamiliar products were made illustrated their abilities to transfer understandings; however, with limited knowledge of material properties, this was mostly applied uncritically**.**

6.2.2.2 Students' application of survey data and modelling to a final product

Section 2.3.6 raises the issue of five-year-old students' tendency to view each phase of the technological process as an end point in its own right and their limited ability to grasp the concept that each phase, each activity, is one step in a more extensive process. The analysis of interview questions in this section examined whether the links between the survey data, the modelling and the final outcome had been maintained by the students.

An important step in the students' technological practice was introducing the concept of market research, and in this case, to gather data from the intended consumer of their product - their mother, before committing to a particular design for their chocolate gift.

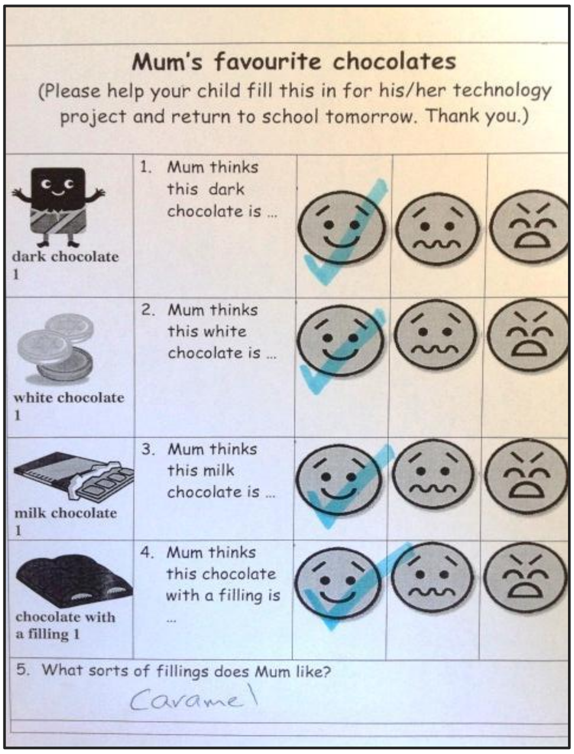


Figure 6.11 Questionnaire for students' mothers

The teachers and I agreed that a simple questionnaire that students could take home to their mothers could be a way of managing this. As shown in Figure 6.11 we designed a questionnaire with images of different types of chocolate printed down one side of the page in place of text, and alongside each one, three emoticons showing a range of expressions. By ticking or colouring the emoticons, the student's mother could indicate how she felt about the each type of chocolate. We considered this would work well for the early readers in this study, and allow them to manage the task independently.

Five-year-old students are notorious for losing notices or simply not delivering them, and the situation in this study was no different. Despite the good intentions of the teachers, it was unclear whether the questionnaires were distributed to everyone in the two classes and, according to the students, very few, if any, reached their destination. Despite this, the Oldpark students understood the reference to a questionnaire during their interviews, and several students talked about "the list", "a chart" or "that piece of paper". It appears that with the assistance of the parent-helpers, these students filled in their questionnaire on the 'making day', based on what they remembered from discussions with their mother, or what they already knew about her favourite chocolate. If a parent was also helper on the day, a discussion was held between mother and child, and the appropriate emoticons ticked or coloured.

Descriptions of a similar situation unfolded during the Dayton students interviews with only Isla referring to the questionnaire with any clarity:

R **How did you know what chocolates Mum liked?**

I Because I asked her when she was there (at school).

R **Ah did you. Yes and did you write it down on a piece of paper?**

I No, it's because we know, because we've got a list on the fridge and it's got um faces of chocolate to see what one you like, and then you put a tick by it to see if you like it.

R **Ok. And so did Mum fill that in for you?**

I Yes.

R **That's the one with the smiley faces? And what did she say she liked?**

I She liked um, she liked milk chocolate and dar- and she doesn't, she says … dark chocolate is yuck, and she likes filling chocolate and … down the bottom Mum said she likes peppermint chocolate.

The remaining students from Dayton school were aware of the questionnaire but their answers were vague and no-one was able to describe what was on the sheet.

What seems contradictory, however, was all but three of the students (Lewis, Kayne and Kristy) were able to identify the type of chocolate that their mother liked. Lewis and Kayne’s lack of knowledge is most likely explained by absences over this period because of ill-health. Kristy’s is unexplained.

On reflection, it seems that the consumer research planned for the students was not sufficiently immersed into their practice and most of the students were unclear about its purpose and value. There was also a problem with the distribution of the questionnaires, with only a few being completed at home. This impacted on the discussions and further meaning-making opportunities that were anticipated within the families, i.e. discussions about the visit to Candyland, the reason for the visit, the different types of chocolate available and which ones were family favourites.

6.2.2.3 Students’ knowledge of the links between consumer feedback and modelling

An element of the technology unit which guided the teachers in this study was to include an activity in which the students modelled their chosen outcome. The purpose of this was to encourage them to think about the consumer of their gift, research that persons’ preferred type of chocolate, and plan an outcome that reflected their research. In addition, the modelling task with play dough or modelling clay was designed to help them consider the size and shape of their gift before committing to a final selection. Thirteen of the 16 students created shapes from which they would make their chocolate gift. A wide range of shapes were developed, not all selected with their mothers in mind. Some were chosen because the students themselves liked them. There were hearts, butterflies, reading glasses, balloons, a snail, a number five and several other shapes (see Figure 6.6). Armed with their questionnaires and their models, the students took turns the following day to work in small groups, and with the help of four parents, set about making their chocolate gift. At the time there was no way of creating moulds from the students’ models, so we elected to match their models with commercially made moulds. The matches were not perfect, but aside from the snail, balloon and butterfly, all students had the opportunity to find a shape that closely resembled their own. Interestingly, no child selected a mould that matched their model. Rosie planned to make a flower- shaped chocolate, but chose a heart and a fairy mould; Lizzie planned to make a heart but chose a star and a dolphin (see Figure 6.12); Mana, who had made a pair of sun-glasses, finally settled on an octopus and a fairy chocolate for his mother. Attending to the information gathered about the mothers' preferred type of chocolate, resulted in designs more consistent with the students' questionnaires.

Twelve of the 15 students who made their chocolate gift matched the type of chocolate with the questionnaire. This included all students from Oldpark School and five of the eight from Dayton School.

Figure 6.12 Lizzie's chocolate gifts for her mother

Three students from Oldpark replaced the white chocolate of the questionnaire with one of three colours that the parent-helpers had made up. Unlike the two little girls who were keen to use the colours, Sean was not altogether happy about this:

R **And what did Mum like?**

S She wrote at the bottom she liked caramel, and she didn't really like white, she liked dark and she liked milk.

R **Right, she liked dark chocolate and milk chocolate. The chocolate that you made for Mum at school, was that the same as what she said she liked?**

S We did what she didn't really like but that wasn't me that was the mums.

R **It was the mums, ok. So the one that you made at school…**

S And the ones were caramel except had colour in them.

R **Right so your ones had caramel inside them…**

S Yeah.

R **like Mum wanted, but you did it a different colour.**

S Yeah.

R Ok. Why did you do it a different colour?

S Because we had colour things to make it have colours but it still tastes the same.

Although there was no intention to compare the results between the two schools, my observations and field notes revealed that the way in which the ‘making session’ was managed differed quite markedly. The parents-helpers from Oldpark School had also been able to attend the visit to Candyland and, as preparation for this, the parents met prior to the visit. These parents had a reasonably clear idea of the purpose of the visit and that the results of the questionnaire were to inform the students’ final constructions.

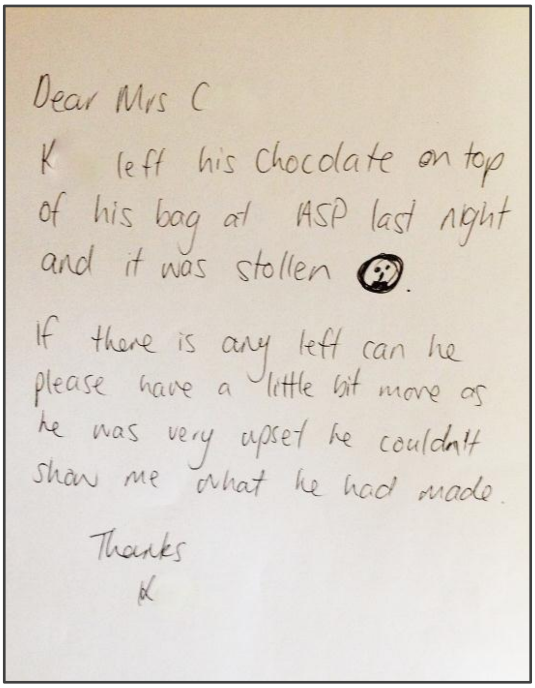

Dear Mrs C
K left his Chocolate on top of his bag at ASP last night and it was stollen.
If there is any left can he please have a little bit more as he was very upset he couldn't show me what he had made.
Thanks
K

Figure 6.13 A letter from Kris’s mother

During the chocolate-making session at Oldpark School, one of the parent-helpers prompted students to refer to their questionnaire and match their gift as closely as possible with this. Although two of the eight parents indicated they liked all types of chocolate so making a match was not difficult, the students appeared to be guided by the results of the questionnaire.

The parent-helpers from Dayton School were a very enthusiastic group but nearly all were unable to attend the visit and, therefore, had not been at the parents’ meeting. As an observer, it became clear they were not as aware of the purpose of the visit or the part the questionnaire was to play in the students’ chocolate-making.

They made no reference to the questionnaire during this session, and amongst themselves, decided to change the task slightly by offering students the chance to "make one for Mum and one for you". This was very exciting for the students but distracted them from the purpose of the unit. Two students made chocolates that they liked and their mothers did not, one ate his before he went home, one ate his when he got home, and one mysteriously lost his at After School Care (see Figure 6.13).

6.2.2.4 Students' consideration of changes to the final outcome

As confirmed by the note from Kris's mother, this was a very positive experience for the students and, with the exception of Lyall, no-one was able to think of changes they would like to make to their Mothers' Day gifts. Lyall made a valid point by stating that he would have preferred to make a snail for his mother rather than using the star and angel fish moulds. Unfortunately there were no snail moulds available.

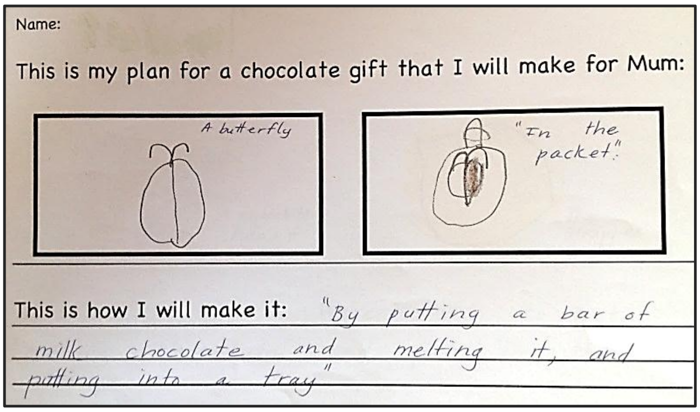

Name:
This is my plan for a chocolate gift that I will make for Mum:
A butterfly
"In the packet"
This is how I will make it: "By putting a bar of milk chocolate and melting it, and putting into a tray"

Figure 6.14 Isla's plan for her Mothers' Day gift

Several observations made during the chocolate-making session are worthy of further mention at this stage. The availability of chocolate colouring meant that some students elected to use these, and in fact were encouraged to do so by one of the parents, even though this had not been considered earlier and was not part of the students' plan.

There was a phase where parents and students enthusiastically experimented with mixing colours and adding fillings to the moulds, but as the energy levels of the parents diminished, some short cuts were made, and at times the students' choice of milk, dark or white chocolate was reduced, and fillings became too difficult to cope with.

Despite the students being aware that chocolate could be created in a variety of colours, the possibility of including this in their chocolate design only arose when the parent-helpers offered to add colouring to the white chocolate. Isla's plan in

Figure 6.14 is typical of those created by Dayton students. Whilst this added to the over-all effect of the final product, it altered the nature of the process that students were working through and, to some degree, devalued the planning and research they had carried out.

6.2.2.5 Section summary of students' procedural knowledge

Sequencing a series of steps in the production of a product was within the capabilities of these students, and whilst they were willing to guess at how an unfamiliar product was made, there was evidence to suggest that several students drew on their prior knowledge in order to explain this. Students' drawings and stories illustrated the transferability of the new understandings gained during their visit to Candyland to the construction of the wooden dinosaur and the chocolate biscuit. The links between the students' modelling, their survey data, and their final outcomes were tenuous, and the importance of securely embedding these stages into each students' technological practice became apparent. Understanding the purpose of each stage is vital, however the cognitive development of individuals meant that some elements of this seemed to be beyond some students' capabilities.

6.2.3 Technical knowledge

An aspect of technical knowledge in the previous chapter was defined as students' ability to identify the equipment and ingredients required to make a nominated product. It is important to note that effective understanding of a technological process requires students to develop an understanding of not only *how* they would proceed with the development of a product, but also *what* they would need in order to do so. Hence, the importance of recognising, and then building, on their existing knowledge of equipment, ingredients, materials and material properties.

6.2.3.1 Students' knowledge of equipment required to make chocolate

The analysis of data gathered before the visit to Candyland portrayed students' prior knowledge of equipment as limited and generally not recognised by the students as a necessary component in the development of a product. Their ideas were drawn from experiences at home and during their early childhood education. Subsequent analysis of data after the visit that is described in this section investigates students' knowledge of the equipment used in making the four items referred to in the previous section, i.e. the chocolate fish, the three-dimensional wooden dinosaur, the Tiny Teddie biscuit and the students' chocolate gift for Mothers' Day.

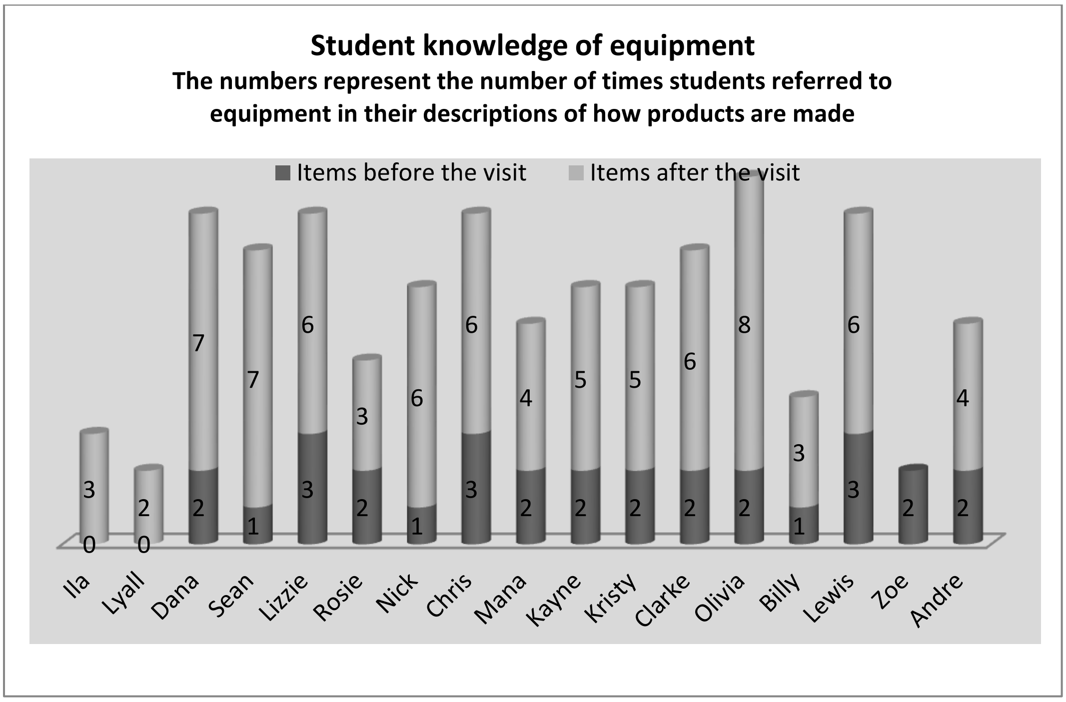


Figure 6.15 Students' references to equipment used in product development

Data was again gathered through the analysis of students' second interviews, their plans for the chocolate gift, and their drawings about their experience at Candyland. Sixteen students participated in at least two of these three data gathering opportunities. Drawn plans for the chocolate gift were completed only by Dayton School students.

Figure 6.15 shows a significant increase in all 16 students' reference to equipment when they described how each of the four items listed above were made. This list includes items such as an oven and a fridge, as well specific machines, such as "a melting machine" or "a big turning machine". Other items which had now become part of their spoken vocabulary included a mould, a bowl, spoons, a cooling machine, a cooling tunnel, a tray, a chainsaw, and a computer. There was a stronger connection between the use of equipment and the construction of a product, and the students frequently attempted to differentiate between what they saw at Candyland and similar items they had at home by prefacing the description of equipment with the word 'special', for example a 'special fridge', 'a special tray' or 'a special machine to melt chocolate'. Andrew demonstrates this in his description of how the Candyland presenters made their chocolate fish:

A They get the special machine to melt the chocolate.

R Yes, good boy.

A And then I put it in the mould…

R Yes.

A …and after that they put it in a special freezer.

There was little change in the number of times the students referred to machinery during the second interview. However, there was less mention of the generic 'machine' and a greater likelihood that the students would use adjectives to describe the function of the machine. Kristy describes what she saw Lance and John doing to make the chocolate fish:

R What were the things they had to do to that big block of chocolate?

D They had to melt it in the big turning machines.

R What happened after you put the chocolate into the fish moulds?

D It went into the cooling machine.

There were many different types of machinery at Candyland with a multitude of different functions - the enrobing machine, the pulling machine, the melting tanks and so on. Although students' attention was drawn to this machinery, and the correct name given to each of them at the time, most students used only part of the name correctly during the interviews and in their story-writing. For example, the melting tank was frequently referred to as the melting machine, and the cooling tunnel was often referred to as the cooling machine or the hard tunnel. Some students substituted the name of the machine with a term that made more sense to them and that described the function of the machine, for example, the enrobing machine was referred to by one student as "the chocolate waterfall" – an exact description of how it appeared, and the melting tank was called "a big circle machine" because it spun around in a circle. It was a valuable exercise to ensure students were exposed to the correct terminology during their visit to Candyland and, although the accuracy of the names given to equipment and machinery was variable, the students' awareness of the function and purpose of equipment during a production line was significantly enhanced.

6.2.3.2 Students' knowledge of heating and cooling in product development

Before the visit to Candyland, very few students made reference to heating or cooling during the production of a product. Only Dana, Kayne and Mana commented on this during discussions about making chocolate. They all considered that chocolate would need to go into an oven or be cooked before it could be eaten. After the visit, there was a sizeable difference in students' awareness of ingredients (and, at times, materials) requiring heating or cooling in order to achieve a final product (see Figure 6.16).

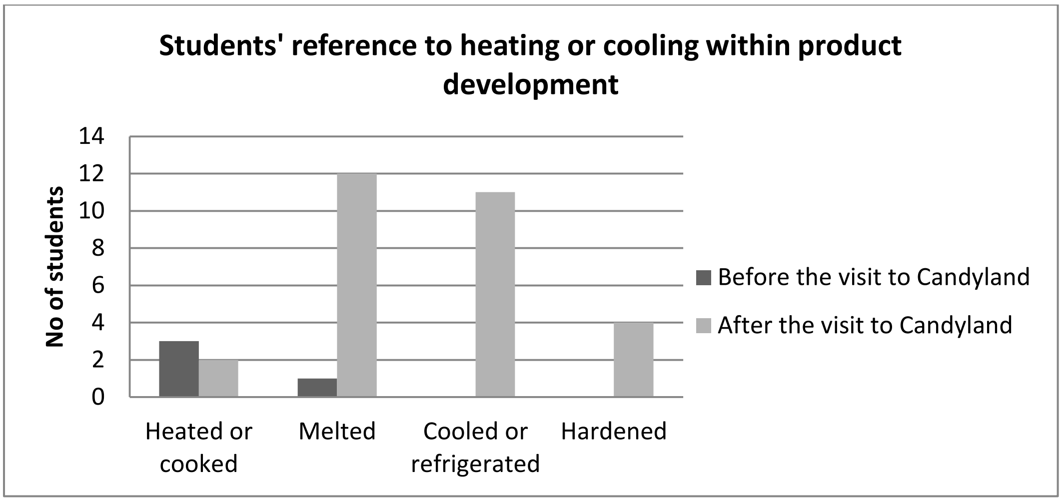


Figure 6.16 Reference to heating or cooling during product development

Fifteen of the 16 students accurately described the heating and cooling of chocolate to make a final product, and, as described in Section 6.2.1, some students transposed the chocolate-making process to manipulating wood and creating the 3D wooden dinosaur. One student reported that melted chocolate in the moulds would need to go into an oven to be completed. For example, Kris wrote: "We are going to pour melty chocolate into a mould, and then put it into a big oven, and then put it in a packet for Mum". It is uncertain whether he confused "the big oven" with the cooling tunnel he had seen at Candyland or whether this was a misconception he held, thinking that all food products are prepared in an oven.

6.2.3.3 Section summary

In summarising the level of student's technical knowledge after the visit to Candyland, it appears that the combination of appropriately levelled presentations and the teaching points delivered by parent-helpers during the visit to Candyland was effective. This resulted in an increased use of the language associated with chocolate-making and greater accuracy of terms used to describe equipment and machinery. Students were more aware of the function and purpose of machinery and there was the higher frequency of process descriptions incorporating equipment and machinery, compared with their previous focus before the visit on ingredient or materials. Figure 6.16 summarised the students' reference to the heating and cooling of ingredients and materials. Although these were not strictly accurate when they were referring to materials, other descriptions reflected the new knowledge they had gained during the visit, with the elimination of some misconceptions they had previously held regarding the preparation of a food product.

6.2.4 Societal knowledge

Societal knowledge is characterised by students' awareness of the interrelationship between technology and groups of people (Moreland, Jones, & Northover, 2001) This is particularly relevant in the context of this study where young students are developing a product for a person other than themselves.

6.2.4.1 Students' recognition of the product consumer being other than him/herself

Findings relating to students' ability to consider the product consumer as being other than him/herself are presented in this section. As described previously in this chapter, the students completed a second interview and participated in a range of post-visit activities. Data relating to this theme were identified more frequently when the students understood the purpose of the visit to Candyland. In analysing the transcripts of the Oldpark School students, all students referred to "making chocolates for Mum", "making chocolates for Mothers' Day" or they spoke about making a model for "Mum's chocolate". Once the students from Dayton School had made their chocolate gift, they were all aware of the intended recipient, however, there was no data to suggest that there was real clarity about who was to receive the gift prior to this. Field notes and the collection of charts upon which Hannah summarised her discussions with the students, indicated quite clearly that these conversations had occurred, but for some reason, the class predominantly made up of male students, did not comprehend the true reason for the visit and the chocolate-making.

Many of the questions asked during the second interview, although designed to gather other information, prompted students to speak about their mothers' involvement in their chocolate making. Some students appeared able to consider her needs very easily, others found the concept difficult to manage and seemed to engage fleetingly with the idea of the chocolate gift being for another person, but were very easily distracted into reconsidering that this might be something for him/herself. Mana's statement illustrates this exactly.

R **What did you do to make the chocolates?**

M Pour it into a mould… and then we waited until it got dried up…

R **Yes.**

M …and then we ate it.

R **Did you eat it at school?**

M Yes.

R **Did you? Did you take yours' home to Mum?**

M No.

R **No? Did you eat yours at school?**

M Yes.

R **Oh did you?**

M I had both, I eated both of them. Yes 'cause I was tricking my mum.

R **You were tricking your mum. Poor Mum! All right, after you've made the chocolates what did the mothers do with the chocolates to make them ready to take them home?**

M Put them into a bag.

R **That's right, good and…**

M And put the ribbon around it.

R **Put the ribbon around it. So after school did you take the ribbon off and eat them up?**

M Yes.

The chocolate was altogether too tempting for this young man to resist and it was likely that the change of focus offered by the parent-helpers, was confusing.

This was a difficult analysis and the results described here are tentative. A number of the students were able to relate to the needs of other people while others struggled, even when considering a close family member such as their mother.

6.2.5 Technology education summary

Data analysis has indicated that students' conceptual knowledge of chocolate and chocolate-making made gains between the initial interview carried out before the visit to Candyland and after the visit. Students have indicated they understand modelling as a purposeful activity. Their descriptions of chocolate-making have been more detailed and show greater accuracy when explaining the process involved, and the equipment and ingredients that are required. Sequencing steps in a production line were explained with some ease although these tended to be restricted to the chocolate-making experiences and were usually limited to between three and five steps. Technology as a domain was less well understood, though some early conceptions were illustrated during the interviews. The links between the students' market research and their final outcomes were tenuous and required prompting from the parent-helpers to fully appreciate the connection.

The opportunity to view chocolate-making first-hand appears to have had a significant impact on the students' use of terminology associated with this context, their knowledge of equipment and machinery and how these function within a production line. Concepts of heating and cooling in the preparation of a food product appeared to be better understood and fewer misconceptions were recorded, however, this was not as well understood when students considered how unfamiliar products might be made. Clarity around who was to receive the students' final product was more difficult to ascertain. At times there appeared to be an uncertainty in the minds of some students and this may have been exacerbated by those parent-helpers who did not receive the information they required in order to effectively carry out their role, and failed to maintain students' focus on making the chocolate gift for Mothers' Day rather than themselves. This was most obvious at the final stage of the unit when the students made their chocolate gifts.

The following section investigates the visit to Candyland as a learning experience outside the classroom (EOTC). The students' understanding of the purpose of the visit, their attitudes towards the visit and their preparation and links to their own practice are examined.

6.3 Learning experiences outside the classroom (EOTC)

As described in Chapter 5, the definition of EOTC in this study is any learning experience that extends beyond the four walls of the classroom and which provides experiences that could not be made available in the immediate school environment (Ministry of Education, 2013). The visit to Candyland, which offered hands-on activities, on-going interaction with the presenters and the parent-helpers, as well as the potential for cross-curricula post-visit opportunities, was a very good match with the teaching genre of EOTC. In Table 6.2 the themes that have been identified for analysis in this section are presented. These are consistent with those analysed in Chapter 5 with the exception of two themes which are no longer relevant - students' expectations of the experience, and whether the student had visited Candyland previously. In addition, a final theme has been added which aims to investigate the role of parent-helpers at two key stages of the teaching unit: (i) during the visit to Candyland and, (ii) during the students' chocolate-making session on their return to school.

6.3.1 Students' understanding of the purpose of the visit

In this section, findings related to students' understanding of the nature and the purpose of the visit are presented. This includes students' perceptions of why they went on the visit to Candyland, and whether they were able to recognise the connection between this and their own technological practice of designing and creating a gift for Mothers' Day.

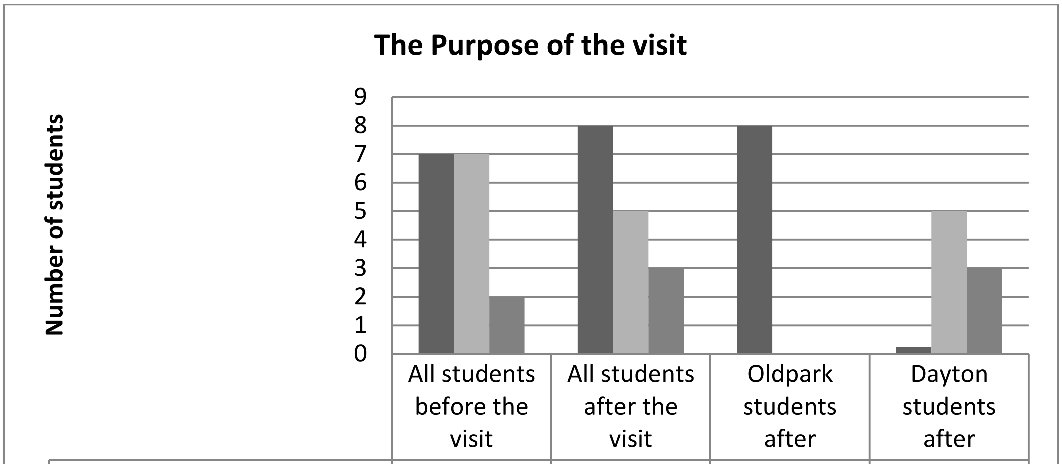
In Chapter 5, the key elements of EOTC to guide this study were described. Because the subject of the teaching unit was technology education, with a technological outcome as its final goal, it was paramount that students understood that the purpose of the visit to Candyland was to gather information to help them achieve their final outcome i.e. the chocolate gift for Mothers' Day.

Table 6.2 EOTC themes for analysis

Code	Themes
6.3.1	Students' understanding of the purpose of the experience Ability to: explain the purpose of the visit link the visit to his or her own technological practice
6.3.2	Students' attitude towards the experience Ability to: express feelings towards the factory visit explain a reason for their response
6.3.3	Students' preparation for the experience Ability to reflect on: ideas for preparing for the visit questions the students asked the presenters during the visit
6.3.4	Students' views of their learning Ability to reflect on: the expected learning opportunities during the visit the learning or help gained at the factory the role of the staff
6.3.5	Students' views of the role of parent-helpers Ability to reflect on: the parent-helpers role during the visit the parent-helpers role when making the chocolate gifts

These understandings would equip them with the all-important 'need to know' factor as they explored the factory site and participated in the activities provided. This would give purpose to the experience and support their learning.

The data used to investigate the above theme were gathered directly after the visit and, as described in Section 6.2, included interviews with 16 students, drawings and stories in which students described their visit and an interview with Rose and Hannah, the two teachers. A photographic record was also collected throughout the various phases of the technology unit, recording the pre-visit lessons to prepare students for the visit, through to the visit and the final gift-making episodes in the classroom. An impromptu interview with two parents, Carol and Jane, completed the data set.



	All students before the visit	All students after the visit	Oldpark students after	Dayton students after
Understood purpose of visit	7	8	8	0.25
Did not understand purpose of the visit	7	5	0	5
Partly understood	2	3	0	3

Figure 6.17 Students who understood the purpose of the visit to Candyland

6.3.1.1 Students' explanation of the purpose of the visit

The first question put to the students in their interview related to the purpose of their visit to Candyland was, i.e. "Can you tell me why we went out to Candyland?" The students' responses revealed two extremes of understanding – one, that indicated complete clarity of the purpose of the visit, the other having little or no understanding (see Figure 6.17). The eight students from Oldpark School referred to their need to find out how to make chocolate and they also described the reason for doing so. Nick explained, "So we knew how to make chocolate for Mothers' Day". In a similar vein, Rosie said, "We needed to learn how to make Mothers' Day chocolate". The manner in which these responses were phrased also suggests students had a sound appreciation of their own involvement, and that the visit was one part of a more extensive technological process. This was indicated by phrases such as, "we needed to learn", "we had to find out", and "so we knew how". In contrast, the students from Dayton School, although making a reasonable guess based on what they did at Candyland, were unable to make the link between participating in the visit, learning about chocolate-making, and the reason for doing so. Mana and Clarke were unable to give a reason for the visit, and Lyall and Kayne based their responses on what they had seen. Kayne said, "To look at the chocolate the man made", and Lyall reasoned that he went to Candyland "for a trip, to see how to make chocolate and lollipops". Billy and Ila expressed a greater understanding of the visit and were able to explain that the purpose of the visit was "to learn about chocolate", but omitted any reference to, or connection with, Mothers' Day. The two examples of Dayton students' story writing (see Figure 6.18) show firstly, that the students had discussed the chocolates that their mothers liked and, several days later, had written about giving their chocolate gifts to their mothers. They had not, however, recognised the interconnectedness of these episodes.

The data indicates that five-year-olds require on-going scaffolding and a range of strategies to help them understand that the individual parts of a technological process are linked, one informing the other, in order to achieve a successful outcome. It appears that without extensive support, many junior primary students will view each task as an end-point in its own right and struggle to piece them together (Fleer, 2000; Milne, 2002; Moreland & Cowie, 2011).

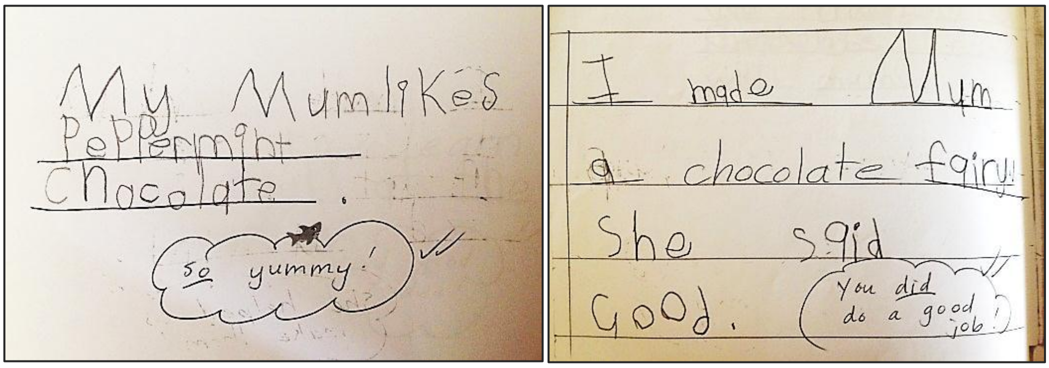


Figure 6.18 Students' stories written after the visit to Candyland

6.3.2 Students' attitude towards the experience

6.3.2.1 Students' ability to express feelings towards the factory visit

The students' attitude toward the visit had more impact on their willingness to engage in the visit beforehand, rather than having a significant impact retrospectively. It is interesting to note, however, that their responses to questions asking how they felt about the visit, i.e. "what was the best part", and "what was the worst part", were all positive. Eight of the students said "it was good", others used descriptors such as "it was great", they were feeling excited or happy, and Lyall summed it up by stating "it was pretty cool!" During the interview with Carol, Dana's mother, the same issue was raised and she made the following comment: "They were quite hyped weren't they, quite excited by the whole thing, the car journey and everything had got them quite excited, and not in the teacher's domain, it was different."

Aspects of the visit the students particularly enjoyed were the hands-on tasks of either making the lollipop or making the chocolate fish. The lollipop-making presentation was spoken about more frequently than making the chocolate fish, and this was also evident in the stories the Dayton students wrote when they returned to school.

Text:
My Mum took us to Candyland. We made a lollipop. The man gave us a piece of candy. I twisted it and it went into a spiral and then I put a stick into it.

Figure 6.19 Kayne's story and illustration of his visit to Candyland

Figure 6.19 shows the story Kayne wrote on his return to school. Aside from the obvious reason that this presentation was the last activity of the visit, and more likely to be easily remembered, the parent-helpers Carol and Jane offered some alternative thoughts about why they thought it was so popular with the students.

J I think that it was probably, more - I think it looked more exciting for them, 'cos it was big and bright and you could smell it, you know, I think the lollipop thing – and then they got given a piece to play with, and it was probably a little bit more of an environment that they didn't have to sit so still and be quiet.

C They could move around a bit couldn't they – they had to really to look around the corner (to see the liquid candy being heated).

R So if you were to compare the two environments, what would you say?

C The lollipop part was more fun for the kids, it had their eye, yeah, it caught their eye more.

J Yeah, and it was quicker, and it was more visual.

6.3.2.2 Students' reasons for their responses

Aspects of the visit that the students did not enjoy were varied – one comment was more social in nature and was a good example of the toll visits can take on young students. Rosie explained that she had had an argument with a friend on the way home. The friend was not happy about Rosie spending time with another child in the class. She said,

Ro When we went to go back to school, me and Sara were arguing.

R Oh were you?

Ro 'Cos we were really, really tired.

R You felt a bit growly did you?

Ro Yeah, and Sara said don't go near Maddy, but I just did go near Maddy.

Other comments related to the organisation of the visit, where one student felt she had had to wait a long time for her turn to ask the presenter a question, and another student felt impatient at having to wait outside the factory before he was allowed to go in. Most other negative comments about the visit included mention of the 'sticky', 'stinky' or 'not tasty' lollipops. Whilst the students thoroughly enjoyed making the lollipops, the after effects were not as popular. Lewis made a thoughtful comment when he tried to explain the difficulty of maintaining dental hygiene when you eat lollipops.

R What was the worst part or the thing that you wouldn't really like to do again?

L Um the worst part?

R Mmm.

L Um…making the candy.

R You didn't like that? No, why not?

L 'Cause, when we're eating, you didn't keep on eating it, and then you brush your teeth so it gets sticky on your teeth, it gets stuck.

R It does, doesn't it.

L And if you leave it like that, your teeth will get yucky and then your teeth will be yucky teeth.

Kristy summed up the views of many of her class-mates with her explanation:

> K I wouldn't want to make the lollipop again 'cos when I got home I took one lick of it and I didn't like it.
>
> **R You didn't like it – Lizzie didn't like hers either.**
>
> K And every time I licked it – every time I *say* it, it gives me a sore nose.

Research carried out by Falk and Dierking (1997) suggested that students who have participated in this type of excursion have excellent recall, particularly of the social dimension of the experience. This was illustrated by the comments made during the interview with the two parents. Dana's mother, Carol, spoke about some drawings and a conversation she had had with her daughter when they returned home. (At this stage Dana had only been at school for a few weeks.)

> C She drew all the people that came with us in the car, and that was quite lovely, that was obviously quite a thing to her, and she put Kristy and her mum talking next to her, so that was quite important. Then she drew two chocolate love hearts, 'cos we had seen those, and then she drew some hugs and kisses. And I said "why have you drawn them", and she said "oh they are for my new friends". So obviously for her, that was quite a big thing, going in the car, and making her feel that she had some new friends (Parent's conversation after the visit).

Jane, the other parent, described a conversation that she overheard in the car on the way home from Candyland in which one of the boys talked about a fly he and his friends had seen in the bathroom, buzzing around inside one of the basins. "Yes", said the parent, "he was captivated by this jolly fly". She was a little concerned that this was the only thing he would remember!

The visit to Candyland was novel, it was relevant to the teaching unit at the time, it was authentic and mostly age-appropriate. It was not as focused as anticipated, and student responses to interview questions and the drawings they made after the visit indicated the lollipop presentation diverted their attention away from the real intent of the visit – to learn how to make chocolate for Mothers' Day. In spite of this, the distraction of making a lollipop offered technologically-based learning opportunities that were valuable in their own right. The students' perspectives of the visit were generally positive, and their reflections identified both social and practical episodes that had an impact on their attitude towards the day. They were able to identify elements of the visit they would like to repeat and those which they would not, but clearly it was the hands-on, practical tasks of making the chocolate fish, and then the lollipop, which were most enjoyable and memorable.

6.3.3 Reflecting on students' preparation for the experience

In this section, I take a retrospective look at how the students prepared for the visit and whether, during the visit to Candyland, they discovered answers to the questions they had devised with their teachers (see Figure 5.9).

6.3.3.1 Students' preparation for the visit and the questions they had to ask

An example of a chart amongst Rose's teaching materials showed that she used a session as an opportunity to discuss question starters, i.e. how students should begin a question with words such as what, where, when, how, who, why or do. Supported by Rose, the students compiled a range of questions to ask the presenter, including where the chocolate came from, how they made the chocolate shapes at the factory, how they put the fillings in, and several others (see Figure 5.9). In the analysis of the interviews before the visit, the students had struggled to describe the questions they intended to ask, with only two students providing a correctly structured example (see Section 5.4.3 for further details of this analysis). Despite the Oldpark students formulating a very useful list of questions with their teacher, they were mostly unable to report on this during the interview, despite many of them being quite clear about the purpose of the visit. In the analysis of the interview after the visit, six students from Oldpark School were able to describe a question they asked, wanted to ask or had more recently thought of asking. Olivia remembered her question and explained:

> **R Remember [your teacher] had a big list of questions, did you have one of those that you (wanted to ask)?**
>
> N Yup.
>
> **R What was your question about?**

N Where do you buy the big block of chocolate from?

R Good question. And did you find out the answer to that?

N Yup.

R Where was it?

N They buyed it from the supermarket.

Two students reported that the question they had to ask, was how to make the chocolate, and one student said his question was why Candyland was built out in the countryside. Andrew unfortunately could not remember the question he wanted to ask and Rosie appeared to be considering her question retrospectively, rather than one she had thought of before the visit. She said her question was, “How do you make those little raisin chocolate things?” The chocolate raisins were an item that the students were introduced to during the visit rather than something they would have been aware of beforehand. Lance gave the children a bowl of chocolate raisins to taste while they were waiting for their turn to make the chocolate fish. The time frame within which the students identified questions to ask the presenters appeared to have become confused. Dana, as in her first interview, was unsure of how to structure a question of this type, and instead reported on the sequence of making chocolate that she experienced during the visit. She said “We needed to melt the chocolate before we put it in the mould”. In comparison, the remaining seven students, who were unable to answer the interview question, responded by shrugging shoulders, shaking their heads or saying, “I don’t know”. It is interesting to note that these students were also unclear about the purpose of the visit.

6.3.3.2 Students’ views of their learning

In this section, the students’ perspective on whether they learnt anything new, and their ideas about the help received from the presenters and the parent-helpers, is presented. The interview questions asked:

Question 4 (Interview No 2): Did you learn anything new during the trip?
a. If so, what did you learn?

Question 6 (Interview No 2): Were Lance and John helpful? How?

The reference to 'new' in interview question No 2, was intended to encourage the students to describe things they learnt at Candyland, things they didn't know before. The word 'help' in interview question No 4 referred to student learning and the goals of the visit, i.e. what help had they received which enabled them to find out how to make chocolate. As the interview progressed, it became apparent that the later question (question No 2) was too complex for most students to understand – they struggled to interpret the term 'new learning', and the wording of the question needed to be simplified.

6.3.3.3 Students' expected learning opportunities during the visit

The first question relating to this section asked students whether they had learnt anything new during the trip, and, if so, what did they learn. Of the 14 students who were asked this question, seven said they did not learn anything new and the remaining seven said they did. Two students were not asked the question. The students who considered that they had learnt something new all spoke about the practical activities of making the chocolates or making the lollipops. Ila's response was similar to others in her class.

R **Did you learn anything new when you went out to Candyland?**

I Um…no. Yes.

R You did? What did you learn that was new?

I Um how to put them in the mould.

R How to put what in the mould?

I Um the melted chocolate.

R Oh ok, how to put the melted chocolate in the mould. Right, so you didn't know how to do that before. Was there anything else that you learnt that you didn't know before?

I Um how to how to twist the, how to make the shape of the lollipop.

Billy seemed resistant to the idea of learning something new, and insisted that he knew how to make chocolates before he went to Candyland, because he had made them with his mother at home. The remaining six students appeared confused by the question. The use of the word "new" in this context, that is, "did you learn anything new", resulted in the students denying they had gained any new understandings. However, in each case, where the question was reworded, the students were able to identify knowledge or skills that they had not known previously. Kayne's response was typical of these students.

> **R Did you learn anything new when you were out at Candyland, things that you didn't know before?**
>
> K No.
>
> **R No? Did you know how to make chocolate before you went out there?**
>
> K No.
>
> **R No? So would that be something new that you learnt?**
>
> K (Shakes head)
>
> **R No? Ok.**

Clarke went to some lengths to talk about 'new' and launched into this description, which gives some insight into how differently this age group will interpret language that, as adults, we expect to be easily understood.

> **R Was there anything else new that you learnt?**
>
> C I have some questions that I want you to ask, but I was new a lot of days ago, not too much days ago, and one time I asked my dad how many days ago I was new - and we'll go back to the chocolate now. About the chocolate, you said I could have two chocolates.

Five-year-olds are constantly challenged by the constraints of their own oral language and their understandings of what adults consider are relatively simple terms. Whilst these students may incorporate words such as 'new' into their spoken language, their concept of the term may be narrow. This has the potential to impact on the collection of data and its analysis, if the researcher does not take time to modify or reword the interview questions in order to ensure the participants fully understand what is being asked.

6.3.3.4 Students' perspective of the learning or help gained at the factory and the role the staff played during the visit

A second question in this section focused on gaining the students' ideas of the help they received from Lance, the presenter at Candyland. It was expected that answers to this question may give an insight into how the students perceived the visit and whether they saw it as a learning environment (Tofield et al., 2003).

Lance was a very experienced presenter who had worked extensively with large groups of children over several years. Prior to the Dayton and Oldpark Schools' visit he was sent information explaining the research project, along with a request for his permission to take part in the research, and a description of the classes and the learning intentions we hoped to achieve.

Lance was very generous with his time, and willingly modified the usual chocolate-making presentation so that it fitted better with our learning intentions. He was assisted by two colleagues during the presentations and this allowed him to explain each stage of the production process and answer the students' questions.

The chocolate-making session was the first of two presentations and Lance introduced this by showing students an example of the big block of chocolate that Candyland purchased to melt down and create their own chocolate products. He explained that once this was melted down, it was reformed into the array of colours, flavours and shapes seen in the factory shop.

At this point, during the first visit by Oldpark students, the children were invited to line up and were then taken onto the factory floor in small groups of six or seven students, where Lance and his colleague John helped them 'spoon' melted chocolate into small fish-shaped moulds. The dynamics of this were a little challenging for both the students and the parent-helpers. Five-year-olds are not known for their patience and the students who were waiting for their turn, and those who had finished making their fish, readily lapsed into entertainment of their own making. Jane, one of the parents, made the following observation about her daughter and friends:

> J Evie made hers (chocolate fish) during that first little making group, that was good, then I came back and the other girls were twirling round so I had to tell them to stop twirling… the ones that had finished were the ones doing the twirling, just jumping – they had done what they had come to do, and they knew that, and game over (Parents conversation after the visit).

In the second visit, this process was modified slightly, and two groups of four or five students were taken onto the factory floor together, one working with Lance, and one working with John (Lance's colleague) at a separate table, speeding up the process and resulting in less waiting and 'twirling' time for the students.

When the students were asked in their interview if John and Lance had been helpful, they were unanimous in their response – each student agreed that the presenters had helped them.

Nine of the students thought Lance and John had been helpful when they made the chocolate fish, and four of these students also thought they were helpful when they made the lollipops towards the end of the visit. Olivia's response was typical of these students. She reported, "they were helpful because Lance helped me spoon (chocolate) into the fish containers".

Billy made no mention of making the chocolate fish and only spoke about making lollipops. He said that Lance was helpful because he showed them "how to make lollipops and how to make the stripe". The remaining five students also agreed that Lance and John had been helpful but they were less descriptive in their replies. For example, Lewis said, "they told us what to do, and we did it, then we learnt to do it". Lewis added, on a more personal level that Lance was "nice and quiet", and Lizzie said "you could tell he liked us being there". Whilst the majority of students made a link with the chocolate-making presentation, there was no obvious connection with their goal to use this information to inform their own practice.

The variety within each presentation ensured that no student was required to rely wholly on one mode of delivery. For example, a large amount of the information presented was during the oral presentation, but the language was uncomplicated and the students appeared to understand the general gist of what was being said.

Figure 6.20 A worker at Candyland demonstrating how to make a lollipop

There was a strong visual component in the presentations and each one included a hands-on activity for the students to take part in. Furthermore, the students were in an authentic working environment and were exposed to the noise of machinery, the smells of the production line, and the visual excitement of the final products coming off the conveyer belt – in total, a sensory rich and stimulating environment (see Figure 6.20).

In order for the students to have their questions answered, there was naturally a reliance on the oral presentations. A question asked during the interview was about whether the students had understood what Lance had said to them. Half of the students said they did understand what he said, and half said they did not. The reasons for them not understanding were interesting. Several of the students said Lance used some words that they did not understand. However, only Dana was able to explain what these were. She said:

D I didn't understand one of them.

R Can you remember what that was, that was a bit hard?

D Yes.

R What was that?

D Um how to mix it all up (the lollipops).

R How to mix it up, you thought that was a bit hard did you.

D Um I've got to find a book about Candyland (Dana, interview after the visit).

Her difficulty in this instance was not being able to understand the process Lance had described of mixing the liquid candy, adding stripes, stretching and aerating it, before creating the lollipops, rather than the word itself. The confusion between what the student possibly intended to say and what was actually said is characteristic of the oral language of five-year-olds.

Lizzie explained why she could not understand Lance. She said, "… I couldn't understand cos I couldn't hear very well and I didn't know what he was pointing at". The parent-helpers also provided a useful perspective when discussing the chocolate-making session. Dana's mother Carol explained:

C Um, I think it was that it had gone a little bit over their heads, and it then broke with the sweets (being given out) and they were up out of their chairs and into it, then they had got up, they'd had that chocolate and they were a little bit excited then – (thinking) wow what's happening next (Parent interview after the visit).

Nick's perspective on whether he had found the answers to his question was a little different and he shed some light on an earlier question asked prior to the visit about "why Candyland was there". He was puzzled by Lance's answer to his question, when he recounted a story about the semi-retired candy-maker named Bill Coker who set up Candyland because he wanted to show people how old-fashioned candy was made (Candyland, n.d.) Nick said, "I didn't understand why there was an old man and he loved making candy and chocolate".

The notion of 'understanding' in the minds of these five-year-olds did not necessarily relate to what had been explained to them, but appeared to include the difficulties they experienced, seeing and hearing the presenters, and understanding big-picture concepts such as that expressed by the founder of Candyland – aiming to retain the skills and practices of an earlier era – ideas far beyond the capabilities of these very young students. Gathering data, and then accurately analysing it, was complicated and, as indicated in Nick's example, the students are not always able to express their ideas clearly, perhaps not having sufficient vocabulary or the background knowledge to do so.

6.3.3.5 Students' perspective of the role of parent helpers during the visit

A high percentage of the students in the two participating school attended some form of Early Childhood education. It can be assumed, therefore, that during this time, the children had participated in visits outside the classroom, including those organised by their families. These family visits usually fit with what is described as informal learning, whereby parents and care-givers take their families to sites such as museums, zoos, aquatic centres and science centres.

The visits are fun, visually oriented, open-ended and usually non-structured (Ash & Klein, 2000). Children attending the types of site listed above are likely to be exposed to many different exhibits but without specific learning goals and generally without preparation or follow-up. The role of the parent or caregiver during these visits tends to be that of a supervisor, guiding the family through the exhibits, answering questions, pointing out exhibits they think may be of interest, and ensuring no one is left behind. Naturally this varies between families and it will be influenced by how knowledgeable the parents are about the exhibits and how the type of visit is valued within the family.

In contrast, the role of each parent-helper during the visit to Candyland was multi-dimensional: they were to provide transport (for which they were reimbursed), to supervise a small group of students, and to guide and support their learning based on the information provided to them. This role was recognised in the study as a crucial one, and time was given to preparing both groups of parents and supplying them with question cards (see Appendix B, p. 243) and a list of products and exhibits to draw students' attention to (see Figure 6.21).

It was important the parents were aware of the research they were participating in, and the impact that their role was likely to have on student learning. In accordance with the learning intentions of the teaching plan, they were asked to use the language associated with chocolate-making, and to explain elements of the presentations that they felt the students would not fully understand.

Figure 6.21 Parent-helpers pointing out the moulds, colours and fillings in the factory shop

Anderson (2003) has reported that visitors' memories of an exhibition were significantly influenced by the socio-cultural identity of the sightseer at the time of the visit.

Similarly, the socio-cultural identity of the five-year-old students attending an EOTC visit, such as the visit to Candyland, would clearly influence what attracts their attention, what they notice as being important, and what they remember. This suggests that parent-helpers can enhance student learning if they mediate and help connect students to aspects of their visit that, because of their age and socio-cultural background, may be ignored.

This support of 'a more knowledgeable other' (Vygotsky, 1994) during the visit, who is able to direct students' attention to the ingredients, equipment and the different shapes and structures to choose from when making chocolate, is invaluable, particularly as this had the potential to inform students' future design decisions.

An example of this can be seen Figure 6.22 which shows Mana's original design of a pair of red chocolate sunglasses. This was a wonderful example of a five-year-old's design idea which was germinated during the visit to the factory shop. Mana was encouraged by one of the parent-helpers to take note of the extensive range of shapes, colours and flavours of chocolate products that were on display (Oldpark school visit, field notes). This provided him with many possibilities for his own final design of the Mothers' Day gift.

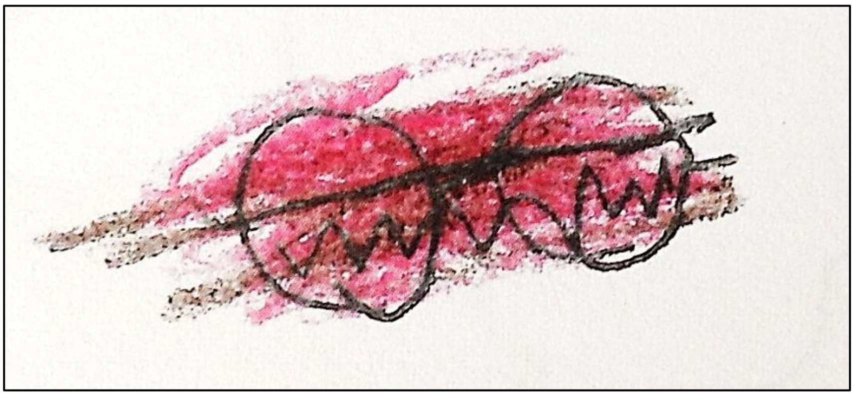


Figure 6.22 Mana's red chocolate sunglasses

Involving parent-helpers in students' EOTC experience requires teachers to take into account the guidance provided by the Ministry of Education. The Te Kete

Ipurangi website (TKI) provides a set of guidelines to assist teachers (Ministry of Education, 2012). In addition, individual schools have their own Safe Operations Plan and/or Risk Analysis and Management Systems documents for EOTC, which are signed off by the school principal or deputy principal prior to an outing. Rose and Hannah complied fully with the regulations set down by their respective schools, but, in addition to parents helping ensure student safety once outside the school grounds, they also recognised the educational role parents could play during the visit. They realised that, in order for students to achieve the goals of the visit, the parent-helpers needed to be fully informed of their role, and conversant with the learning goals of the technology unit. Rose made the following observation:

> Yes, I think it was made quite clear that it wasn't just entertainment - we were going out there because we were going to do the process. The card you [the researcher] gave them, made it quite clear what they needed to be pointing out, and actually when we walked through the shop part before we went in, I thought they did a really good job - they were really talking to the kids and they were being quite diligent about you know, doing the job carefully, looking at all the things, and I got really good feedback about how, what a wonderful trip they thought it was, not just you know 'we enjoyed it' but it was really good for the kids, and then they actually liked the idea that they kids were going to follow up hands on and make something from that (Teacher's interview after the visit).

Hannah raised an interesting point about making links between what the students saw at the factory and how they would be making chocolate back at school.

> I was quite pleased with the parent help on the whole, and I think they were pretty good and watched the children and talked to them. … I felt that link to what we saw at the factory could have been covered a little bit better, and that was when I said to you I don't know if you remember, like at the factory they had a big melting machine, we had the microwave and I got the children to draw pictures so we could make those links, you know comparing

> the two, what we saw at the factory and what the factory used and what we used at school (Teacher's interview after the visit).

As previously discussed, sixteen students were interviewed after the visit, and they were asked whether the parent-helper in their group helped them in any way. Seven of the 16 students responded and their replies varied from providing transport (and being allowed to stay the night), to helping the students make the lollipops and the chocolate fish. Dana described how her mother helped.

R **Did they (the parent-helpers) help you in any way when you were out there?**

D Yes.

R **What sorts of things did they talk to you about, do you remember?**

D They talked to us about pouring the drops into the spoon, into the moulds.

R **Oh ok so the little drops of…**

D Chocolate.

R **…chocolate into the mould, ok. You didn't want great big huge spoonfuls.**

D No otherwise they'll go all over the others and no one else will get to do it.

R **Yes you're right. And when we went into the shop did the parents help you find some special things in there?**

D Yes.

R **What sorts of things did you look at?**

D Um moulds, different kinds of moulds and different coloured chocolate.

Nick's father was one of two men who were able to assist during the visit and Sean described how he helped their group of little boys.

R **… when you were out at Candyland, were the parents good at helping?**

S Yes.

R **What sorts of things did they do to help?**

S Well Nick's Dad helped us pour it in (the melted chocolate).

R And did he encourage you to look at some things there?

S Yes.

R What sorts of things did you look at?

S Like the moulds. One was a car one, and a mould, and a motorbike one, and a truck one, and a van one, and a green racing car one.

When Jane and Carol (two of the mothers) were interviewed, they also referred to the coloured chocolates.

J We looked at the colours of the chocolates and they were quite intrigued with that – and as we walked further along, somebody spotted coloured chocolate and that really grabbed them didn't it – "oh look over there, I want a blue one", "I want a green one".

C Quite different from what we normally see wasn't it?

J Yeah, they were quite intrigued by those weren't they – not like the old white chocolate.

Looking at the photographic record of events back at school, the students' drawings and final products were liberally sprinkled with colours, imaginative shapes (see Figure 6.23) and sometimes fillings – all design ideas that they observed and discussed with their parent-helper during their visit.

The remaining nine students during this part of the interview were either unable to respond to the question or thought their parent-helper had not helped them. There was some disparity between the opinions of students who explored the factory in the same group, and it became important to persist with questions and, where necessary, to modify them by using a range of verbs other than 'help' or 'helping'.

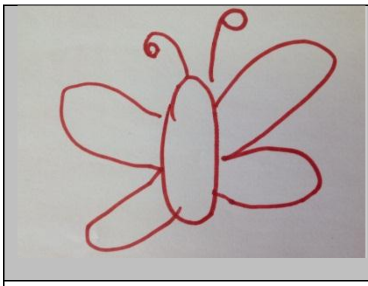
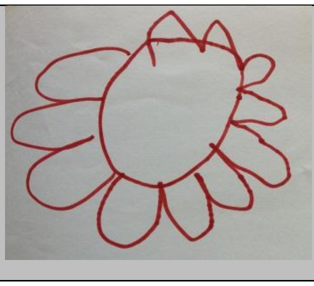
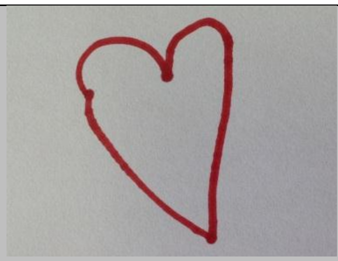
		
A student's plan for a chocolate butterfly	A student's plan for a chocolate flower	A student's plan for a chocolate heart

Figure 6.23 Students' sketches drawn during a class discussion

For example, when students said they had received no help from their parent-helper, they were prompted with questions such as: "Did they encourage you to look at some things", or "Can you remember something they talked to you about", or "What was something they showed you?" This made an important difference to the way in which the students answered, and, as a result, 14 of the 16 students were then able to describe items that the parents had encouraged them to look at, four of the 16 listed items that a parent-helper had shown them and six students explained things they had seen. Only two students remembered a conversation they had with their parent, although photographic evidence suggests that a great deal of discussion occurred throughout the Candyland experience. By using the prompts listed above, the students were able to provide more information about the interactions with their parent-helper. The conversation with Kayne was typical of those where students maintained they received no help.

R **So did Mum help you in any way when you were out there?**

K Mmm-mmm (shakes head).

R **No? Did she explain any of the things that Lance was doing?** (Kayne shakes his head) **No, ok. Remember when you went to the shop at Candyland where all the things were, did Mum encourage you to look at any of the things in the shop? Can you remember the things that you saw?**

K The moulds.

R **Right, good boy.**

K And some chocolate.

R **Yes, what sorts of chocolate did you see in the shop?**

K Chocolate fish and lollipops.

R Yes, good. Did you see any other things in there?

K And I saw a basketball chocolate and an Easter egg one.

R Right. Good boy. Anything else you saw in there? No. I'm glad you mentioned the moulds. What was your favourite mould?

K Um the heart one.

R The heart one. Good. Did you choose that for Mum as well?

K Mmm-hmm (Nods head).

The challenge that came with interpreting the interview questions was particularly noticeable in this section of the interview, and gaining information from the students required more prompting and rewording of questions than previously. The students' inability to describe this aspect of their visit provides a valuable illustration of Bruck and Ceci's research (1999) in which it is argued that, in order to access a child's memory of an episode, the researcher needs to know how a child commits information to memory. Having been present during the episode under discussion, I was able to select strategies that would encourage recall.

Figure 6.24 Student creating different coloured chocolate

The students in this study had a very narrow concept of the term 'helping'. They appeared to associate 'helping' with practical activities, for example driving the car, pouring chocolate into moulds, and twisting the lollipop, rather than 'helping' to achieve the learning goals of the visit.

As a result of rewording questions, and asking what they had seen, what they were shown, and at times what they "talked about" with their parent-helpers, some students were able to provide a more detailed response.

Along with explaining how the parent-helpers assisted them, these responses also gave a useful insight into products they noticed in the shop and the influences these had on the design decisions made for their Mothers' Day gift.

The students referred to rainbow-coloured chocolate, the candy house, the green frogs, the dinosaurs, hearts, and the chocolate buttons. They mentioned chocolate faces, chocolate teeth, chocolate raisins and the many different shaped moulds that they could use to make their own chocolate shapes. As can be seen in Figure 6.24, the students were creative in their selection of colours for their gift, and despite the apparent influence of the parent-helpers, the shape, colour and flavour of their gifts were of their own choosing and students were not coerced into making selections they were unhappy with. Apart from Sean, who complained that the parent helpers didn't give him the type of chocolate he needed, other students were more than content with their final products, despite the options parent-helpers made available to them, which they had not initially planned for.

The interview questions that asked students about their learning provided limited but useful information. As suggested above, five-year-olds can struggle to interpret these types of questions because of limited oral language skills and conceptual knowledge, and it is valuable, when selecting methods of data collection, to be aware that students' responses may not accurately convey the ideas they have but are unable to express. Using the interview as a qualitative research tool would, in most situations, allow the researcher to "get inside the head" of the respondent, but when working with very young participants, such as those in this study, a range of data collection methods help provide more reliable results (Tuckman, 1972 cited in Cohen & Manion, 1994, p. 272).

6.3.3.5 Section summary

Understanding the purpose of EOTC, and having the endpoint of the technology unit clearly in mind, was 'the glue' that would hold an extensive process such as this together. Five-year-old students appeared to require on-going scaffolding and a range of strategies to help them understand that the individual parts of the whole process needed to be linked, one informing the other, in order to achieve a successful outcome.

The visit to Candyland was intended to be novel, relevant to the teaching unit at the time, authentic and age-appropriate. The analysis of data suggests that these goals were mostly achieved. The inclusion of the lollipop presentation appeared to initially divert students' attention away from the chocolate making. However their perspectives of the visit were positive and the hands-on practical task of making the chocolate fish was enjoyable, memorable, and students were able to draw on the details of the experience after the visit.

The notion of students having the 'need to know' factor when participating in an EOTC has been raised several times in Chapters 5 and 6. I see it as the cornerstone of the teaching unit, upon which other concepts can be built, and without which, the experiences and learning opportunities will lack cohesion. The analysis of data in this chapter indicated that in a well-supported environment, five-year-old students are able to identify information they wish to find out about. However, this required them to not only consider the how and why of chocolate-making, but also to project their ideas forward and consider, in advance, what they would need to know in order to make the gift for Mothers' Day. Structuring a question that would help them achieve this is a skill these students are still developing and, along with the uncertainty of the purpose of the visit experienced by many of the Dayton students, only half the participating students were able to describe information they required.

The way in which students view their learning, and their interpretation of what they do and do not understand, was difficult to establish. Half of the students said they learnt nothing new during the visit to Candyland, but when questions were modified to include what they were shown by the parent-helpers and the staff, or what they talked about or did, many of these students were able to identify elements of the visit that they had not known about previously. The data also suggests that a number of these students related not being able to understand to the difficulties they experienced seeing and hearing the presenters, or to extraneous occurrences that was not seen as particularly important at the time, but were beyond their understanding, for example, the story of the founder of Candyland.

The interview questions that asked students how the parents had helped them had limited outcomes. Half of the students were unable to suggest any occasion when the parents helped them, and the remainder described practical help making the chocolate fish or lollipops, rather than any reference to their learning. As mentioned previously, five-year-olds can struggle to interpret quite simple questions because of limited oral language skills and it is important to recognise that their responses may not accurately convey the ideas they intend, and are unable to express.

The final section in this chapter discusses the characteristics of five-year-old students in greater depth, particularly with regard to the oral language they use and understand, and how this has been progressed as a result of their visit to the factory.

6.4 Characteristics of five-year-olds

Table 6.3 Themes for analysis of five-year-olds' data

Themes
Interest and participation Students' demonstration of: • an interest and participation in the chocolate-making context • an ability to listen, comprehend and respond appropriately to speaker • an ability to focus on a topic for a sustained period of time
Transfer and application of ideas Students' ability to: • extend what has been learned in one context to a new context
Language development: Students' ability to use language skills for increasingly complex purposes, i.e. • use a range of topic-specific words to create meaning • use a range of personal-content words to create meaning • substitute conventional language with similar known vocabulary to convey meaning (Ministry of Education, 1996; Ministry of Education, 2007)

The two previous sections have focused on student learning in technology education, and student understanding of and engagement with an EOTC experience.

This section of analysis from phase two, organisation during the visit and development after the visit, aims to further investigate three elements of learning by five-year-old students identified in phase one: (i) students' interest and participation, (ii) their ability to transfer and apply knowledge, and (iii) their language development. The themes that have emerged from both the literature and the data, and which will allow an in-depth analysis of each of these elements, are listed below in Table 6.3.

6.4.1 Students' interest and participation in the chocolate-making context

The analysis of data in section 6.3.2 indicates that the two classes of five-year-olds were excited about their visit to Candyland, and highly motivated by the activities offered to them during the chocolate- and the lollipop-making demonstrations. These hands-on, practical activities were a high priority when selecting Candyland as a potential site for investigating chocolate-making. Educational researchers consistently report on the positive impact a practical activity can have on students' learning. Borun, Massey and Luther (1993), for example, describe the "powerful combination of hands-on exhibits and explanatory text" that can produce what they describe as the "aha" moment, or breakthrough in a person's understanding (p. 202). Similarly, in this study, it was anticipated that by physically making a chocolate at the factory, the process would be experienced, explained, and a conceptual link created with the knowledge the students required to make their own chocolate gift.

The data used to investigate the themes described in this section were gathered directly after the visit and, as described in Section 6.2, included interviews with 16 students, their drawings and stories that described their visit, an interview with the two teachers Rose and Hannah, and the impromptu interview with Carol and Jane, two of the parents who accompanied the students to Candyland.

As in the previous sections, a photographic record was also collected and used to cross-check items raised in the interviews and other student documents.

Student's caption

At Candyland I made a big lollipop. Lance gave us a piece of stripy candy and we twisted it. Then we curled (it) into a circle, and then we put a stick into it (Isla, drawing and story after the visit).

Figure 6.25 Isla's drawing and story of her visit to Candyland

6.4.1.1 Student interest in the context (of chocolate and chocolate-making)

When reviewing all the data gathered after the visit, the interest and enjoyment experienced by the students throughout the visit, and during the follow-up activities, was clearly evident. The Dayton students' drawings and stories, completed on their return from Candyland, gave the clearest illustration of the elements that the students most enjoyed and remembered about their visit.

This task was open-ended, allowing the students to select an aspect of their visit to draw and write about that was most appealing. Six of the seven students who completed these drawings drew a picture of themselves creating a lollipop (see Figure 6.26) and one student drew himself holding the chocolate fish he had made.

6.4.1.2 Students' ability to listen, comprehend and respond appropriately

On a more technical level, but equally important in how well five-year-old students are able to engage with a context such as this, was their inclination and ability to listen attentively, comprehend what was being presented to them, and respond appropriately to the speakers. The difficulties experienced with the students' limited understanding of relatively simple vocabulary was discussed in section 5.4.3 and, in order to gain a response from the students during the interviews after the visit, it was necessary to reword some questions. During the visit to Candyland, the parent-helpers were asked to accept a similar responsibility. Their task was to clarify, in simple language, any aspect of Lance's presentation that they thought might be too advanced for the students to understand. Rose, the teacher from Oldpark school, was particularly clear about this duty and explained: “(You need to) make sure you’ve got enough parent help, that parents aren’t just there for their own entertainment really, that they’re there to help the children and extend their learning.” (Rose, pre-visit interview)

When Hannah, the teacher from Dayton school, was asked to comment in her after visit interview on how well she thought the parent-helpers had carried out their jobs, she made specific mention of the conversations the parents had had with the students. She said, “I thought they did a really good job, they were really talking to the kids and they were being quite diligent about, you know, doing the job carefully.” The interview with the two parents revealed how this process was developed and the impact it had on the students’ learning. Janel, Kristy’s mother, described part of the chocolate-making presentation that her daughter did not understand.

R **Did you talk to them about what was happening at all?**

C Yeah, with Kristy, was it the cooling board where the chocolate was runny?

R **Ah – the chocolate curtain**

C Yeah – Kristy couldn’t see, couldn’t understand, couldn’t comprehend why it was runny and I hadn’t heard everything he’d said either. Yeah she couldn’t understand that it had come down and it was flat.

The explanation provided to Kristy at this point enabled her to report later on, with some accuracy, how Lance helped them make their chocolate fish, but the transformation of the chocolate, moving from a solid to a liquid state, was left out of her explanation. Understanding the stages of the chocolate-making process was within her capabilities, but the science that sat behind the process was too complex.

Associated with the challenges of deciphering students’ limited context specific vocabulary, was their occasional literal interpretation of language. This tendency can impact on how students interpret events and how they remember them – sometimes giving the impression they have failed to notice important details of their experience. An example was Olivia's response to a question that asked what she had seen when she went to Candyland. She replied, "my place". Further questioning revealed that when she travelled to Candyland in her friend's car, she had passed the house where she lived. Another example, this time from Olivia's twin sister, Rosie, shows how young students can confuse the meanings of words and attach their own incorrect associations. When Rosie was asked about the questions she needed to ask at Candyland, she explained:

R **What was your question about?**

N Where do you buy the big block of chocolate from?

R **Good question. And did you find out the answer to that?**

N Yup.

R **Where was it?**

N They buyed it from the supermarket.

This was incorrect, but a subsequent conversation with her teacher, Rose, concerning the origins of bulk chocolate, or 'the big block of chocolate', explained how this association might have occurred. Rose said:

> … I sort of felt that we had to say that the chocolate was made in another factory, you know, like we'd covered it in school how the cocoa bean is picked and it's dried and whatever, so to me there was a little gap which I tried to cover. (Teachers' post-visit interview)

Rosie appeared to have confused 'factory' with 'supermarket' and made the assumption that bulk chocolate would be purchased at a supermarket. That was where she and her family made their weekly purchases, and it was a logical step to reason that bulk chocolate would also be purchased there.

The five-year-old students in this study were competent users of a large bank of high-frequency words and, when the context was of interest to them and they were familiar with the ideas and language associated with the context, they were able to participate in conversations and share simple but accurate interpretations of what they had observed. A factor which impacted on this was the breadth of their understandings of language, and the restricted use they had of some vocabulary and commonly used terms. Limited understanding of the changing states of matter also hindered one student's perception of the chocolate-making process.

6.4.2 Students' transfer of ideas and application to a new context

The data used to investigate this theme was gathered during the interviews after the visit and the students' drawings and stories that describe their experiences. An on-going photographic record supported each set of data.

In Chapter 5, reference is made to the outcome of both the technological activity and the EOTC requiring students to draw on existing knowledge in order to accurately interpret a new experience. Instances in the data when a transfer of ideas has been identified have been divided into two categories for analysis: those instances when a student drew on knowledge experienced within his or her family, or during pre-school education, and those that were drawn directly from the experience at Candyland.

6.4.2.1 Ability of students to extend what has been learned in one context to a new context

Sixteen students participated in the second interview and, of these, 15 answered questions about how they thought the wooden dinosaur and the Tiny Teddie biscuit had been made. The students' answers to these questions were the primary source of data for this section of analysis.

A question about the wooden dinosaur was put to the students first, and as explained in section 6.2.2, the selection of the wooden dinosaur was intended to elicit students' ideas about the construction of an item not related to food or chocolate-making, and to offer them the challenge of considering a context that they were less familiar with. This question resulted in five of the 16 students making a direct link with how they understood chocolate was made. Dana suggested that the people in the toy factory would "get a dinosaur mould" and then "get some wood and put it inside". Billy made a similar suggestion and added "they'd have to make it cold so it could harden". Olivia also thought the material that was used would need to be hard and they would "put it in the freezer". She thought the spikes on the dinosaur would be made by squeezing the material – "they'd pinch those with their fingers". The first suggestion made by Kris replicated the process he had observed when making chocolate. He said, "Get some chocolate and pour it into a dinosaur mould". After handling the dinosaur he realised that he had made a mistake and offered a further suggestion:

R **Ok. You have a feel of that.**

C There doesn't, it's not ….

R **It's not what?**

C It doesn't feel like chocolate.

R **No, no.**

C It's made out of wood.

R **It's made out of wood, good boy. So how do you think it's been made then?**

C Colourful wood being cut up…

R **Yes.**

K And they've changed all the … they've cut the wood out for the spikes.

As Kris's father was a professional painter and Kris had seen him working in their garage at home, he went on to explain some of the finer details that he thought might be involved in making the wooden dinosaur.

K (They've) got a bit chopped - coming off, then they put it, put little bits in a tray, and then they would take it to a dumping room and dump it. Then they would come back and do something to these ones and cut these pieces off.

R **Yes.**

K And they would have cut around, they would have cut around this, not cut it out. Then they would have cut around this bit here a little bit. It looks like a seesaw like that.

R **It is like a seesaw, isn't it?**

K It looks like a rollercoaster with seats at the back, and seats at there, and seats at the front.

R **Fantastic. So when they'd done all that, what do you think might be the last thing that they would need to do to get it ready for the children to play with?**

K Um, make it all smooth and bumpy.

R **Good thinking, good thinking.**

C And cut little round things round here so it would go in.

Four other students appeared to be testing ideas, aware of the chocolate-making process but also understanding that wood was a different material with different properties. Nathan explained his ideas:

N Um they would have got some special material.

R Yes. What do you think the special material is?

N I don't know.

R You don't know. Ok. And then what do you think they might have done?

N Put it in a special machine and then it got hard.

R Right, so the material was nice and hard. Then what would they do to make that?

N Um…then they got paint and then they got some wood and then they paint the wood and then they cut some more and then they made these spikes.

Sean thought the wood would need to be wet before you could cut it, and Clarke and Rosie both thought you would need "little bits of wood" to begin with.

The remaining six students offered suggestions that were reasonably logical and based on what they could see of its structure. Gathering detail from them required extensive prompting and appeared to be a more challenging task for them.

In comparison, Isla was very concise in her description and said "It might have been made by hard wood, and then they painted it a colour, and then they made it into shapes". Lyall was the most vociferous student and enthusiastically described how he thought the dinosaur might have been made, drawing on some of his previous experiences:

R What would they do to make it? You have a feel of it.

L Make the wood.

R Yes, good boy.

L And some, make the wood then make some colour on it.

R Good boy.

L And oh so they paint it on the wood.

R **They've painted the wood, yes you're right, yes.**

L And then, and then they cut it in half and they've breaked it up, and then, and they've cut those bits, and there, and this one too, and they make little breaky stuff, and you can take (it) off and you can make it back.

R You can make it back, it's just like a jigsaw isn't it?

L Mmm.

R Good boy, good thinking. How do you think they would have cut that?

L Cause it would be like a - it can be a dinosaur.

R It is a dinosaur. But how do you think the people would cut it? What would they cut it with, do you think?

L Um with a really hard saw and cut it really good.

An indication of Lyall's previous experiences either at home, pre-school or at school is illustrated by his reference to "a really hard saw" and putting "some colour on it".

The next source of data for this section came from interview questions that related to how the Tiny Teddie was made. This small chocolate biscuit was intended to provide students with a context similar to what they had observed at Candyland but one that required some additional steps to complete its construction. Twelve of the 16 students were asked this question.

Seven of these students said you would put chocolate into a mould and two others referred to using "a shape" or "a shape thing". Only one student mentioned using melted chocolate, and one other said the biscuit mixture would need to be "dry and hard". Nick remembered the chocolate buttons he had seen at Candyland and thought these would be used to make the Tiny Teddie biscuits. These were all concepts and ideas that had been introduced during the Candyland experience, but equally could have also been introduced in the home or pre-school environments – the exact source of these ideas was therefore uncertain.

A number of students, by drawing on their prior knowledge and experiences, recognised that the Tiny Teddie was largely made up of a biscuit mix. Five of the girls identified using "a mix", "getting the mixture and ingredients", making it "into a biscuit" or using "dough" to make the Tiny Teddie. Two of the boys also noticed that two different materials made up the Tiny Teddie, but were unable to name them. Lyall said you would need to "put stuff on the front" and Lewis said there was "something hard" on the front.

These interview questions were usually prefaced with, "Thinking about what you saw at Candyland, how do you think the dinosaur (or the Tiny Teddie) would be made?" During the interview with Sean, however, a prompt was also introduced that helped him consider making the Tiny Teddie in much greater detail.

R **How you think the people in the factory may have made that Tiny Teddie.**

S They […] of the little Teddy shape and then put chocolate on the back.

R **Yes, yes, I think that they would have done that. What about this other part? What do you think, how do you think they might have made that part?**

S Um…

R **Not too sure? It's a bit like a biscuit isn't it? Have you seen Mum making biscuits at home?**

S Yeah.

R **How did she make the biscuits?**

S Mmm you get all the ingredients out and we got a recipe book…

R **Yes.**

S …and then…we put butter into the bowl and then we put golden syrup to melt.

R **Mmm-hmm golden syrup to melt?**

S No we put it into the oven to melt.

R **The oven to melt, right.**

S And then we crack an egg.

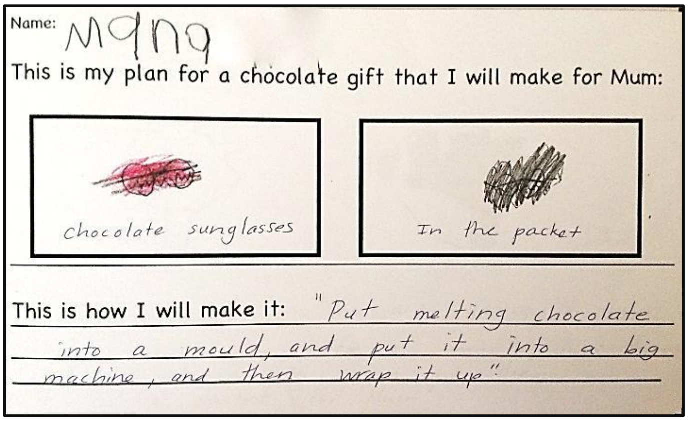
R **Mmm-hmm.**

S I think.

R **There usually is an egg in biscuits isn't there? Mmm-hmm.**

S And I don't remember.

By linking the question to an activity that Sean was very familiar with, he was able to provide a detailed description of how to make a biscuit, however, it appeared unlikely that he would have initiated this independently.



The final analysis in this section was of the drawn plans for their chocolate gift created by the Dayton School students. These provided some results that were not revealed during the interviews.

Figure 6.26 Mana's plan for his red chocolate sunglasses

Four of the six students who completed a plan stated that they would use melted chocolate to make their gift. Clarke included using "a bar of milk chocolate", and two students added wrapping or packaging their chocolate. Trays, moulds, 'big machines' and ovens were all included as part of the process.

Mana's plan showing the red chocolate sunglasses he wanted to make for his Mothers' Day gift provided an excellent example of the students' broadening ideas, and illustrated their developing ability to transfer prior or new knowledge, in order to plan for a new experience (see Figure 6.27). The realisation that chocolate came in a huge range of colours and shapes enabled him to think far beyond the conventional bar of milk chocolate that he would previously have experienced.

In these examples, the students drew on their prior knowledge most effectively when the task was personalised and the context was a familiar one. This was further enhanced when students were familiar with the materials and material properties that were required to create the biscuit or wooden toy.

6.4.3 Students' language development

The investigation of students' language development within this study was introduced in section 5.4.3 and data was presented which illustrated the range of language competencies observed amongst the 16 participating students. As previously described, oral language plays a significant role in students' thinking and learning, and on-going development will allow them to increasingly engage in discussions, ask questions, and refine their ability to listen and understand the spoken language of others. In this section, whilst there was no expectation that the skills for expressing feelings, guessing, or for reasoning and probability will have changed in the short space of time between the pre and post visit interviews, it was of interest to examine if the students' use of topic-specific language and personal-content words may well have been extended as a result of the visit to Candyland and the extensive teaching and learning opportunities that had been provided. This is particularly relevant in this study as it relates to an expectation that students in their first year of school will be aware of and understand "new words" (Ministry of Education, 2009b) and may attempt to use them in their speech and writing (p. 43). Evidence of students substituting conventional language with similar known vocabulary was also investigated.

The data used to investigate this theme again emanated from the interviews after the visit to Candyland and the students' drawings and stories about their experiences.

6.4.3.1 Students' use of topic-specific words to create meaning

Figure 6.28 shows a comparison of the students' use of topic-specific language, as it relates to chocolate-making, before and after the visit. The increase in vocabulary ranged from the least improvement of one new word, through to Billy's increase of 11 new words, and with an average improvement of 4.5 words per student. Fourteen of the 16 students included 'melt' and 'mould' in their conversations, competently varying the syntax as appropriate, and four of the 16 students used verbs such as spooned, poured and mixed. Twelve students referred to the flavours of chocolate, i.e. white, milk and dark chocolate, and two included the flavours, fillings, and colours of chocolate. The students appeared to understand that Candyland used bulk chocolate to make their products, as they did when they made their Mothers' Day gift – hence the reference to chocolate buttons or white buttons by Nick, Billy and Olivia, and the 'big block of chocolate' by Sean and Kristy. As a result, there was no further mention of individual ingredients apart from the occasional comment about items such as peanuts. This only arose when the questionnaire was being discussed and their mothers' favourite type of chocolate was described.

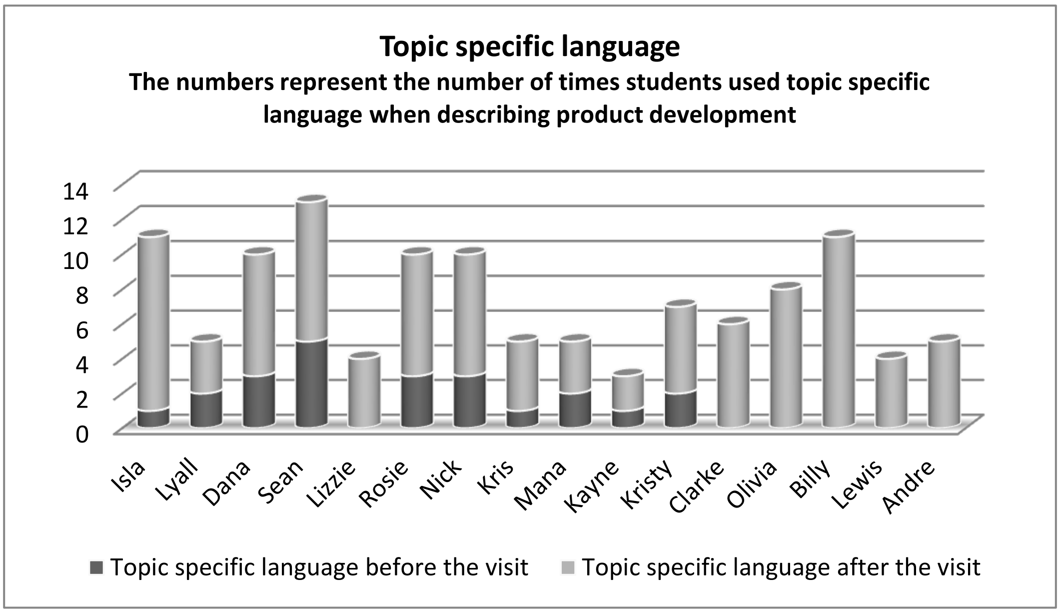


Figure 6.27 Students' use of topic specific language

Sean's description of how he made his chocolate fish at Candyland is a good example of his developing confidence and competence in using the new vocabulary of this context.

R **How did they make them (the chocolate fish)?**

S They got the big block of chocolate that we were going to make the chocolate fish out of and they melted it in that melting machine. And then they got it out with a big bucket and then they poured it in and then we poured it in.

R **And then you poured it in.**

S Yeah.

R **And what did you pour it into?**

S Um the fish mould.

R **The fish mould, that's right. What happened after that, what do you remember that they did?**

S Then they put them in a big fridge.

Olivia demonstrated her growing familiarity with chocolate flavours and fillings with this description when discussing her Mother's chocolate preferences.

R And what sort of chocolate did she like?

O Um milk chocolate.

R Milk, right.

O Dark chocolate.

R And dark, right.

O And caramel.

The students appeared to have discarded ideas about the individual ingredients that may be required to make chocolate, and paid minimal attention to the equipment used. Instead, with their increased knowledge of the language associated with chocolate-making, and an improved knowledge of the range of chocolate products offered at Candyland, they focused instead on the process involved, and the multitude of colours, flavours and fillings that could be obtained.

6.4.3.2 Students' use of personal-content words to create meaning

In section 5.4.3, the students' use of personal content words was investigated, finding a small number of words that would not normally be part of the vocabulary of five-year-old students. Identifying this type of vocabulary is subjective and difficult to measure, but it does help identify some of the experiences and activities in which the students have taken part with their families and during their pre-school education. It also helps explain the ideas and understandings that they shared during their interviews and other data-gathering activities.

With the introduction of the wooden dinosaur as a focus for interview questions on product development, several of the boys were able to provide an insight into the experiences they had had at home. Kayne spoke about "building" the dinosaur and using a "chainsaw" to cut the wood. Lewis referred to needing "a really hard saw", and Lyall thought the dinosaur was made out of "metal". Each of these is an example of vocabulary that was not used by the other student participants. Kris was particularly talkative during his interview and provided several examples of words commonly used by himself and his family. After naming the type of dinosaur that had been shaped into the jigsaw puzzle (a stegosaurus), Kris explained that his father was a painter who does “quotes and stuff”, and “he’s got a chainsaw and a drill”. He went on to say that his father makes things “in his workshop” and that he had a “computer” with “fishing games” on it. A further insight provided by Kris was his reference to “God and Jesus” when he was asked why all the products shown on the discussion chart had been made (see Figure 6.8). Though this vocabulary is of little significance on its own, the snippets of information volunteered by these students did help paint a more detailed picture of the life they live and the devices and artefacts they had become familiar with.

6.4.3.3 Students’ substitution of conventional language with similar known vocabulary

At the time of the post visit interview, the students had been engaged with the context of chocolate and chocolate-making for 2 ½ weeks. During the interview before the visit, some students had struggled to find the words to express their ideas and resorted to substitutions using words such as “things” or “thingies”.

Figure 6.28 The cooling tunnel at Candyland

This tendency had reduced by the second interview, and students appeared to be more confident users of the context-specific language that had been introduced over the previous two weeks.

A small number of topic-specific terms proved difficult for the students to retain, and students experimented with similar, known words. Five students appeared to attempt to substitute the word “hardened” with words such as “dry”, “dried up”, or “cooled up”. The cooling tunnel (see Figure 6.29) was another term that they had difficulty remembering, and the students described it in a number of ways, usually partially correct, for example, the “hard tunnel”, the “cooling machine”, “the cold room” and “special fridge”.

Lewis, possibly because he contracted chicken pox and missed most of the preparation for the visit, had forgotten the name of the fish mould and referred to it as a fish shape. Two other students, although correctly using the word “mould” in their descriptions of making other products, also referred to the fish moulds incorrectly, calling them “fish containers” or “fishy packets”.

The students’ use of substitutions when they referred to machinery and equipment also fits well into this category. As discussed in section 6.4.1, the students generally identified items of machinery used in product development in terms of the function that each one performed. For example, Dana talked about the “big turning machines” in place of a conching machine, Sean referred to the “melting machine” in place of an enrobing machine, and Andrew prefaced each piece of equipment that he recognised as similar to one he had at home with the word “special” i.e. “a special freezer”, and a “special machine”.

These examples all show the emerging confidence and competence with which students have been able to engage in conversations about chocolate and chocolate-making. Through repetition over the two-and-a-half weeks after the visit to Candyland, some terms had become very familiar and easily absorbed into the students’ every-day language. Other terms were being used inconsistently by the students, sometimes correctly, sometimes not, and a small number of terms, usually the names of items that had not been incorporated into the classroom conversations, e.g. the specialist chocolate-making machinery, were named for their function rather than their conventional name, e.g. the melting machine.

6.4.3.4 Section summary of the characteristics of the five-year-olds

The five-year-old students in this study willingly engaged with the context of chocolate and chocolate-making that was offered during this teaching unit. No student gave any indication that they were reluctant to participate in the activities offered during and after the visit to the factory. They were competent users of a large bank of high-frequency words, and able to listen attentively and respond appropriately in small group situations, though less so in whole class situations, which were led by adult presenters with whom the students were unfamiliar. The breadth of the students’ understandings of language was limited, and this was a factor in a small number of misunderstandings and misinterpretations that emerged during the interviews after the visit. The students' concentration span, which was identified in early planning stages as being an important consideration, also proved to be a limiting factor when discussions or explanations became too lengthy during the visit, or when the students were required to wait for more than a few minutes to take their turn at an activity. Some information imparted by the presenters during this time appeared to have been ignored by a small number of students as their attention had shifted elsewhere. Distractions in the environment, or any concerns held by a student regarding school or family, also appeared to affect their capacity to concentrate for sustained periods of time.

The data gathered during and after the visit to Candyland showed that the students were able to transfer information from one context to another. This was most effective when the new context was familiar to the students and where they had knowledge of the required materials and their properties when describing the development of a product. When comparing the topic-specific language used by the students before and after the visit, there was a significant increase in the vocabulary associated with chocolate and chocolate-making that had been absorbed into the students' every-day language. They demonstrated a greater awareness of the process involved in making a product and the colours, flavours and fillings that could be included in the chocolate-making process. Other terms were used inconsistently by the students, and these tended to be the specialist chocolate-making machinery, the names of which had not been reinforced in the classroom. In order to discuss these during the interviews, some students substituted conventional language with similar known language in order to convey meaning.

6.4.4 Chapter summary

Chapter 6 has described the visit of two classes' of five-year-olds to Candyland, along with a description of the activities and tasks carried out when the students' returned to school. The teachers' responsibilities during and after the visit were explained, as was the role carried out by the factory presenter and his colleagues. A key element of this account is the part the parent-helpers played in both transporting and supervising the students to Candyland, and guiding and supporting their learning during the visit. It also described the assistance parents provided in the classroom when the students made their chocolate gift for Mothers' Day.

Incorporated into these descriptions is the analysis of the second phase of data gathered during the students' visit and immediately after the visit. This was structured into the same three areas of investigation described in Chapter 5; technology education, learning experiences outside the classroom and the characteristics of five-year-olds.

The analysis of this data confirmed that the visit to Candyland was a novel experience, it was relevant, and it was age-appropriate for the two classes of students. The context of chocolate-making which provided the basis of the technology unit and the learning experience outside the classroom, ensured that students were eager to visit the factory and excited at the prospect of making a chocolate gift for Mothers' Day. The inclusion of the hands-on, practical lollipop making presentation proved to be a minor distraction from the real intent of the visit, but this, along with the chocolate-making opportunity were described by the students as being the most enjoyable and memorable aspects of the visit.

Participating in the visit with a clear purpose enabled students to identify information they required to make their chocolate gift. Where this was not effectively developed, the stages of the visit and later chocolate making activities appeared to lack cohesion and relevance for the students involved.

The process of technological practice carried out by very young students requires constant support and guidance. It is a complex experience which involves investigating a context, followed by designing and constructing an outcome for an identified consumer. In this study, when the students understood the purpose of the visit to Candyland and how this was to inform their practice, they were better able to assimilate and then apply their new understandings.

Similarly, the data indicates that a five-year-old students' ability to recognise the links between modelling their ideas, gathering their survey data, and creating their final outcomes were tenuous and there were limitations on the data collected for this finding. The students required the support of teachers and parents to methodically ‘connect the dots’ and clarify how the pieces of the process came together in order to create an appropriate outcome.

Sequencing a series of steps in the production of a chocolate product was found to be within the capabilities of these students. They were able to use the new knowledge gained during their visit to Candyland and apply it to the construction of other products. This tended to be considered uncritically, however, particularly when the transfer of ideas was applied to unfamiliar items and where students had a limited understanding of the materials and their properties required to assemble the product.

The students’ oral language was particularly significant in enabling them to participate fully in the conversations and presentations experienced before, during and after the visit. Whilst the students were competent users of a large bank of high-frequency words, the breadth of their understandings of language was limited, as was their knowledge and use of context specific vocabulary. The latter was noticeably extended over the period of the teaching unit, but several commonly used words and phrases were at times misunderstood or misinterpreted by the students. In situations where the students experienced difficulty finding the words to express their ideas, they typically resorted to using substitutions or approximations, drawing on other familiar vocabulary to express their ideas. This tendency had diminished by the end of the unit and students appeared increasingly confident in their use of the context-specific language that had been introduced.

Chapter 7, the final data presentation chapter, describes a series of interviews three months after the visit to Candyland, which aimed to establish how the understandings that have been illustrated in this chapter had endured over time.

Chapter 7

Findings 3: Enduring understandings

7.1 Introduction

Chapter seven introduces the third and final phase of this study. This chapter examines the enduring understandings of the students participating in the study, once the focus and impetus of the teaching unit ended. It presents data gathered six months after the students had gone on their visit to Candyland to discover how to make chocolates for Mothers' Day, and the subsequent making of their chocolate gifts.

The three areas of EOTC, technology education and the characteristics of five-year-old students into which Chapters 5 and 6 were organised are continued in this chapter. However, a number of the themes that were the basis of analysis in the previous chapters have been condensed and are now presented as five questions. The answers to these questions will begin to address the third research question which seeks to identify the learning outcomes of a technology unit for five-year-olds that incorporate an experience outside the classroom?

Q1 What evidence is there of students' understandings of materials and material properties six months after the visit to Candyland?

Q2 What do students understand of how products are made six months after the visit to Candyland?

Q3 What are students' memories of the purpose of the visit to Candyland six months after the visit?

Q4 What context-specific language has been retained six months later?

An important element of an EOTC experience is that it is appropriately novel (Falk & Balling, 2001) and memorable. These questions, answers to which emerge from the data collected six months after the visit, may give an indication of the elements of the visit and the chocolate-making experience that were most memorable for the students. For this reason, and unlike the previous two data chapters, the focus of this chapter is on the students alone.

The number of student participants had by this time reduced to 12 students. Sean, Zoe and Lewis had moved to other schools, and Andrew and Clarke were both unwell at the time and not available to interview. Mana, who was also unwell, attended school and participated in the interview but was noticeably tired and, at times, unresponsive.

After the chocolate-making unit had been completed and the final interviews carried out, it was clear that there was a strong on-going interest in the chocolate-making context, with several children reporting the pictures and stories they had seen in books and television advertisements about chocolate-making, or experiences they had had at home making chocolates. This interest carried on for several months (informal personal communications with the teachers at the time of the student interviews six months later).

The data presented in the following sections of this chapter were gathered through individual interviews with the 12 remaining students and supported by a range of photographs taken during the interviews. The photographs offered an interesting addition to the data set in that they captured the personalities and mood of the students as they responded to the set of questions.

Figure 7.1 Lyall trying on the toddler's jandals

The selection of items used as prompts for the interview questions was carefully considered to draw out students' conceptions of materials, procedures and use of language

The items included a chocolate coated Christmas tree, the chocolate fish made during the students' visit to Candyland, the chocolate gift they made for Mothers' Day, and a toddler's jandal (usually referred to as a thong or a flip-flop outside New Zealand). The chocolate Christmas tree, the new chocolate product introduced during the final interview, was approximately 10 cm tall and filled with marshmallow. The upper surface of the Christmas tree was covered with hundreds-and-thousands which some students referred to as sprinkles. The jandal had three distinct parts to it, a co-polymer sole (a type of plastic used as cushioning in footwear), a synthetic rubber thong and an elasticised heel strap. The new items were also selected because of their expected appeal to young students. During the final interview, the items appeared to influence how well the students contributed to the discussion and the complexity of their responses. The toddler's jandals, for example, invited an immediate reaction; students found them very engaging, immediately handling them, and several students tried them on (see Figure 7.1). When discovering that the jandals were too small for them, the students responded with great delight and volunteered a number of comments about their younger siblings.

7.2 Technology Education

This section of analysis is presented under two headings, students' conceptual knowledge and procedural knowledge (see Table 7.1). These headings are consistent with those analysed in the previous two data chapters with the exception of societal knowledge and technical knowledge, which were not a focus at this point of the study.

Table 7.1 Themes for organising data in Chapter 7

Knowledge	**Theme**
Conceptual knowledge	*Students' ability to:* • name a range of materials and recognise each one has particular properties
Procedural knowledge	• describe in sequence how a nominated product is made

7.2.1 Students' conceptual knowledge

Q1 What evidence is there of students' enduring understandings of materials and material properties?

To maintain consistency with the previous two data sets gathered before and directly after the visit to Candyland, students were not asked to name materials or to describe material properties. This information was gleaned during this third and final interview when students were asked to describe (i) how the chocolate

Christmas tree and the toddlers jandal might be made, (ii) their memories of how they made the chocolate fish at Candyland and (ii) recollections of how they made the chocolate gift for Mothers' Day. In the analysis of data resulting from this interview, it was intended to examine the understanding the students had retained as a result of their earlier experiences, namely preparing for and participating in, the visit to Candyland. In addition it was anticipated that the data would present students' understanding of a small number of materials and their properties, through the examination of the plastic and rubber jandal.

During the course of the interviews, the students referred to a range of materials and, at times, individual ingredients. When describing how the jandal was made, they included materials such as rubber, plastic, string, leather, nails and cotton. Six students thought the sole of the jandal was made from rubber, and four thought it made of plastic. Three students thought the elastic heel strap was made of string and two others named the strap as either leather or cotton. With the exception of one student, there was no indication from any these responses that students associated the selection of the materials with the properties that each one offered. Lizzie proved to be an exception and spoke about choosing "good glue" when making the jandals. In response to my question about how the manufacturers might connect the heel strap to the jandal she reasoned:

L They have tied it around here and put it on with some good glue.

R What do you mean by good glue?

L Well, glue that doesn't come undone.

R Is there some glue that's not very strong do you think?

L Like just ordinary glue - which is not very strong.

Descriptions of how the jandal was made elicited far more detail from the students than they gave about the wooden dinosaur or the Academic bear in the interview conducted prior to the EOTC visit. The reasons for this are not clear, but may indicate a developing knowledge of materials and product development which naturally occurred over time, depending on the experiences the students had had at school and with their families over this period.

The jandal had several clearly defined ‘parts’ to it, for example, the sole, the thong, and the elastic heel strap. This may have enabled the students to isolate each part and speak about the steps in its construction with greater ease than the other two products. The wooden dinosaur, although made of several parts, is more clearly made of one material. This, however, was not the case with the Academic bear as it had several, easily discernible parts - legs, head, ears, eyes, and a mortarboard with a tassel (see Figure 5.2). Yet the students’ discernment of this multi-material construction in the interview prior to the EOTC visit was not evident.

Questions associated with the three chocolate products, the chocolate fish, the marshmallow-filled Christmas tree and the chocolate gift for Mothers’ Day, elicited responses with an extensive range of materials and ingredients. Three students, who coincidentally provided the most detailed responses to questions, attempted to include the ingredients required to make the bulk chocolate. For example, sugar, sugar cane, milk, flour, cream, vanilla and butter were mentioned. Lyall described making the chocolate Christmas tree by seemingly drawing on the knowledge he had developed prior to the visit, in which the students had explored the origins of the cacao tree and the cocoa bean, and how chocolate was made. He said:

> They had to put some sugar in them, and some milk, cause milk chocolate has milk, which like – you can’t make it with dark chocolate. And what was the other thing again? Sugar cane!

This was an interesting response, as in the interviews immediately after the factory visit, the students generally over-looked this and there was little attempt to describe these ingredients. Rather, they tended to refer to chocolate as a whole ingredient to be used when making a chocolate product. For example, Lyall’s description of how three different chocolate products were made during his interview after the visit did not include reference to the ingredients or a supply of bulk chocolate for use when making the products.

When describing how the chocolate Christmas tree was made, the remaining nine students listed chocolate, sprinkles (referring to hundreds-and-thousands), marshmallow, icing and cheese as being the materials required to make this product. Cheese, butter, cream and icing were suggested by those students who were unfamiliar with marshmallow as a filling, and they may have substituted the name of the yellow filling with a known product of a similar colour. As in previous descriptions, very few of the students referred to material properties or commented on the reason for the changing state of materials during the production of a product. This is not to suggest that they were unaware of these changes, as indicated by Kris and Lizzie. Kris made the link between pouring chocolate and the need for melted chocolate to do so. He said, "it needs to be soft so you can pour it and put it in a cold oven". Lizzie remembered that it was necessary to melt chocolate before it was poured into the moulds as did all the students, although four students struggled to find the right word to describe this changed state. These students used words such as melty, runny, and soft and squishy to describe the melted chocolate. Seven students also remembered that the chocolate needed to harden before it could be removed from the moulds and/or eaten but again some struggled to find the right words to describe this. Kayne explained:

> K …you pour chocolate into the fish and then you wait until they say you can eat them
>
> **R Mmmm, and so why did you have to wait?**
>
> K Wait for them to get right, so you can eat them and if they're not right you might get sick.

Of the 12 students, eight referred to the need for the melted chocolate to harden, cool down, dry, or in Kayne's case, "to get right". Their general awareness of the changing state of the chocolate during the process of creating new chocolate products appeared to be understood but at times a small number struggled to clearly articulate their descriptions.

A final observation is that no student in these interviews transferred their understandings of chocolate-making to describe how the toddler's jandal was constructed. This had occurred in the interview directly after the visit when the students described how the wooden dinosaur was made. Apart from Lizzie, there was no mention of melting materials or using moulds to create the jandal shape, although this closely resembled the process generally used to make a jandal. Lizzie described the process as she understood it:

> Firstly they would have made some sort of mixture and they would have melted it and then they would have put it in the place where it all gets hard and - but not all that hard. And then they would put the strap on and then

> they'd do the model like this, and they'll put the strap on (Lizzie, interview 6 months after the visit).

Her inclusion of the word 'model' suggests that she was also beginning to understand more of the experimental and design phase of technological development.

Although the students appeared to have become more discriminating in how they described the construction of these products, their limited understandings and experiences prevented them from anticipating how unfamiliar materials such as plastic and rubber might be used. They tended to offer a simplistic critique of the materials in each product, and relied on the visual and tactile cues presented rather than being able to draw on a more in-depth knowledge of how a material could be manipulated, or how it might respond to heating and cooling.

7.2.1 Students' procedural knowledge

Q2 What do students understand about how products are made six months after the visit to Candyland?

The data analysed in this section again focused on how the students thought the chocolate Christmas tree and the toddler's jandal were made. As referred to in the previous section, the toddler's jandal (see Figure 7.2) had three distinct parts to it, a sole, a rubber thong, and an elasticised heel strap. In addition, the students were asked if they could remember how they made the chocolate fish during their visit to Candyland, and later how they made their chocolate gift for Mothers' Day. Again, the selection of these two new items was deliberate – the toddler's jandal was intended to elicit students' ideas about the construction of an item not related to chocolate-making, similar to the use of the wooden dinosaur and the Academic bear in interviews prior to the factory visit. It would provide a context with which they were less familiar and materials that were not part of the construction of the items in the chocolate-making intervention. The chocolate Christmas tree (see Figure 7.2), as with the Tiny Teddie discussed in Chapter 6, was intended to provide students with a similar product within the chocolate-making context, but one that required some additional steps to complete its production. This product varied from the other two in that it had a marshmallow filling and the surface was covered with hundreds-and-thousands.

Figure 7.2 The chocolate Christmas tree and toddlers' jandals used during the interview six months after the chocolate-making unit

The analysis of data indicated that all 12 students had retained some understanding of product development to describe, with varying levels of complexity, the steps required to construct a product. As in the previous two data chapters, each step represented one discrete part of the production and it was counted whether the explanation was correct or not. The students' descriptions of how the chocolate fish was made at Candyland resulted in seven students providing more information than they had directly after the visit, two students describing the same number of steps, and two students providing one less step in their descriptions. Five of the six boys mentioned using machinery to melt the chocolate in the factory, and several students referred to equipment such as the cooling tunnel to harden the chocolate, and moulds used to create the fish shapes.

The students' descriptions of how they made the chocolate gift for Mothers' day showed fewer gains. In Table 7.2 it can be seen that six months after the visit, five students were able to describe one to three more steps of a process, four students described fewer steps and three were the same as they had described directly after the visit. A number of students indicated they had forgotten what happened and seemed to be relying on their memory of the event rather than applying any logic to how the chocolate gift had been made. Billy said, "I forgot that …I don't remember any – 'cos it was a long time ago". Similarly, Nick said, "I don't remember", and Sophie explained, "I can't remember so much about that but I think I might have made a little heart, and I think a little butterfly".

Table 7.2 Steps required to make the chocolate gift

Name	Chocolate gift after the visit	Chocolate gift 6 months after the visit	Total change
Kris	2	5	+3
Mana	4	6	+2
Isla	5	6	+1
Rosie	4	5	+1
Olivia	5	6	+1
Lizzie	5	5	+0
Kayne	5	5	0
Lyall	3	3	0
Kristy	5	3	-2
Dana	4	2	-2
Nick	4	2	-2
Billy	5	3	-2

At one extreme, Olivia, the student who previously appeared to be interpreting questions in a very literal manner, responded in this way to the question asking how John and Lance helped them make the chocolate fish. She said:

O They smoothed it out (the chocolate).

R Yes okay, what did they do next?

O They put them in the dryer thing

R That's right and what did the chocolate look like when it went into the dryer?

O Fish

R Little fish – right and how did we make the fish?

O You get it from somewhere like the fish and chip shop and they make it.

R Oh okay – what happened to the little chocolate fish then?

O They were all done

R And what did they look like when we got them back?

O Real fish

My intention was to prompt Olivia into describing the changed state of the chocolate and to perhaps include mention of the moulds used to shape the fish. Clearly, the questions did not reap the intended results and it was difficult to interpret her description without significant background information.

The interview questions that focused on the chocolate marshmallow-filled Christmas tree offered some interesting results, which far out-weighed the results obtained from the chocolate gift. In many respects, this was not anticipated because one task was primarily a memory task and the other, although within a similar context, was to envisage the construction of a product that they knew little about. Table 7.3 illustrates the additional steps that 11 of the 12 students were able to describe when explaining how this product might have been made. Billy was the only student who made no gains in his description, but by this stage of the research, it was clear he was uncomfortable when taking risks or when attempting to visualise the construction of a product that he knew little about. Several students made a logical attempt to describe how the marshmallow could have been positioned inside the Christmas tree. Kris described the process in this way:

L First they make the marshmallow and then they make the chocolate. And then they put the chocolate in the oven and then they took it out and they probably dip the marshmallow in the chocolate and put the hundreds and thousands on top of it.

Lizzie went a little further and wrestled with what the correct sequence of construction might be. She said:

L They would melt it (the chocolate) and then they'd put it in the mould and then they'd mix it up.

R What would they mix up?

L The chocolate, and then they would put some filling, then they'd put it in the mould. Then they'd put it in the fridge. But that wouldn't melt because the chocolate's on the outside. No, before that, just before that, they'd put the hundreds-and-thousands on and then they'd put it in the fridge.

R Why do you think they'd put the hundreds-and-thousands on first?

L Because, then if they put the hundreds-and-thousands on second, they won't stay on – because it can't stick to the thing, because it's all hard.

Table 7.4 shows a comparison between the student's descriptions of the Tiny Teddie and the chocolate Christmas tree. The construction of these two products is different, but the number of elements in each product is very similar – the Tiny Teddie has a biscuit front, embossed features, and a chocolate base. The chocolate-coated Christmas tree has a marshmallow centre and hundreds-and-thousands sprinkled over the surface.

The table below (Table 7.3) shows an overview of the increased number of steps that the students were able to include in their descriptions. Compared with their descriptions of how to make a Tiny Teddie, 10 students had increased the number of steps described, one student decreased his number of steps by one, and one student reported the same number of steps.

Table 7.3 The number of steps students used to describe how to make the Tiny Teddie and the marshmallow-filled chocolate Christmas tree

Name	**Tiny Teddie after the visit**	**Xmas tree 6 months after the visit**	**Total change**
Olivia	3	7	+4
Dana	4	7	+3
Kayne	2	5	+3
Isla	4	6	+2
Lizzie	5	7	+2
Mana	4	6	+2
Kristy	4	5	+1
Nick	4	5	+1
Rosie	3	4	+1
Lyall	3	4	+1
Kris	6	6	0
Billy	5	4	-1

The most significant difference in these descriptions centred on the students' increased awareness of how to construct the different parts of an item. Consideration was given to encasing the marshmallow inside the chocolate, creating the shape of the Christmas tree and including the hundreds-and-thousands on the outside of the product.

Another noticeable difference was the students' reference to mixing or combining ingredients in order to construct the product. Six of the 12 students included this element into their descriptions of the Christmas tree compared with only one in the interview directly after the visit to Candyland when they described the Tiny Teddie.

As mentioned in the previous section, nearly all the students referred to the melting and hardening of the chocolate during the production of the various chocolate products, though some reverted back to using approximations when they were unable to remember the correct terms. Data from the interview directly after the visit, indicated that all the students had been confident users of these two terms, or of their derivations, at that time.

In comparison, the students' descriptions of how to make the toddler's jandal provided a higher number of steps than in their descriptions of the wooden dinosaur and the academic bear (see Table 7.4). The lowest number was described by Mana who was unwell on the day of the interview. The highest number of steps expanded to eight, nine and ten steps, and this was a noticeable increase from the students' descriptions of the wooden dinosaur, in which the steps ranged between one and eight. This was an increase of nine students describing more steps in the process, two describing fewer steps, and one student describing the same number of steps. A typical description by the students is this example of Isla's. She explained:

I They might put some leather on it and then they might spread something hot on that. And they might put some elastic around that and put like some plastic, or something around there.

R And how would they get it all together?

I Put like, find something with those on them (the plug on the end of the thong), and then they might push it in so they stay in.

R How would they get that bit (the elastic) on there?

I They might have tied it on to that bit (the bottom of the thong)

During the analysis of data, every effort has been made to ensure that the procedure for counting the steps is both consistent and objective. However, I am very aware that trying to ascertain whether a prompt merely encourages the student to provide further information or whether it suggests further information is fraught with difficulty.

Table 7.4 The number of steps used to describe making the dinosaur and the toddler's jandal

Name	Dinosaur after the visit	Jandal 6 months after the visit	Total change
Rosie	3	10	+7
Kristy	2	8	+6
Kayne	4	8	+4
Isla	4	7	+3
Dana	4	7	+3
Lyall	3	5	+2
Lizzie	4	6	+2
Kris	8	9	+1
Billy	3	4	+1
Olivia	3	4	+1
Nick	7	6	-1
Mana	4	2	-2

To gain a wider perspective of the gains or losses over the six months, Figure 7.3 has been devised. This shows the development of one student's procedural knowledge as it relates to making chocolate products before the visit to Candyland through until six months after the visit. This shows the development of one student's procedural knowledge as it relates to making chocolate products before the visit to Candyland through until six months after the visit. The biggest gains can be seen between the period before and after the visit with minor losses and gains occurring six months later. In the interview before the visit to Candyland, Kristy had a very limited view of how she might make chocolate for Mothers' Day. The picture she drew to show how you might make chocolate included a bowl and some cheese. She was not asked about the chocolate fish during this interview, however the question relating the Freddo Frog, elicited a logical response based on what she observed and her prior experience of making school lunches at home. She suggested four steps which included making the chocolate, drawing a face, writing "Freddo" on the front and then cutting out the shape the way her mother created shape sandwiches for her school lunch - by “squishing” them down with “a little container”.

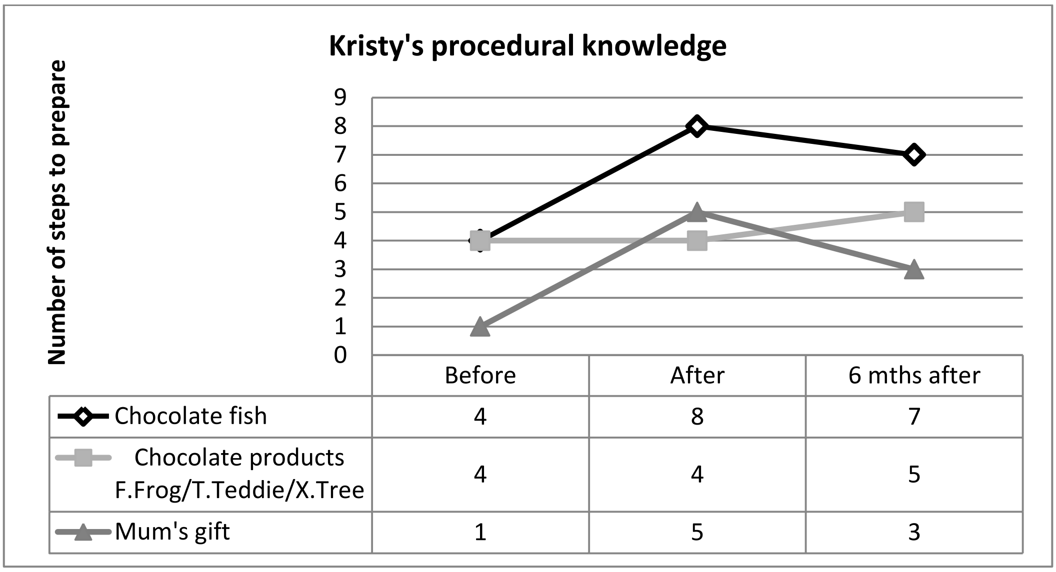


Figure 7.3 One student’s procedural knowledge development

After observing the chocolate fish being made at Candyland and making her Mothers’ Day gift, Kristy was able to offer a more detailed account of how each product was created. She was aware that a number of ingredients were used to make chocolate, including “cocoa and sugar”, and that “a big turning machine” was used at Candyland to melt the bulk chocolate. She referred to the use of a mould to create the different shapes, an oven or microwave to melt chocolate, the “special fridge” to harden the chocolate, and referred to wrapping or packaging the product at the end of the process.

When Kristy was asked about how Mum’s gift, the chocolate fish and the chocolate Christmas tree were made six months after the visit, she no longer included the machinery involved in the process, and there was little mention of fridges or microwaves to melt and harden the chocolate. However, she did indicate awareness of melting and hardening the chocolate but without the association of household appliances which would normally generate the changes. For example, when discussing the Christmas tree, Kristy said:

> K They melted some chocolate and they, when it was hard - they put it in the mould and they, and then they put sprinkles on it and then they put some marshmallow in it.

R **Good girl, exactly right. What do you think they would have done last? What would be the last thing they would do when they were making?**

D Let it dry and go hard.

Her description of how the Tiny Teddie was made in her interview directly after the visit was again very logical but lacked the detail associated with making the individual parts. She said: “Mmmm, they made it into a biscuit, then they put it into shapes, and then put chocolate on the back of him”.

Taking a broader perspective, Table 7.5 shows the gains and losses achieved by all the students over the six-month period. Comparisons are made between the students’ descriptions of the chocolate fish made at Candyland, the chocolate gift made for Mothers’ day, and differences between how the students considered the Tiny Teddie biscuit and the chocolate Christmas tree were made. The table also shows gains and losses in the number of steps students were able to describe when they talked about how the dinosaur and the toddler’s jandal had been made. The final column shows the overall gains or losses achieved over this period.

Table 7.5 All students’ procedural knowledge development

Name	**Change between fish and fish**	**Change between gift and gift**	**Change between Tiny Teddie and Xmas tree**	**Change between dinosaur and jandals**	**Total difference in change**
Olivia	+3	+1	+4	0	8
Dana	+3	-2	+3	+3	7
Kayne	0	0	+3	+4	7
Kristy	+1	-2	+1	+6	6
Lyall	+1	0	+2	+2	5
Rosie	-4	+1	+1	+7	5
Isla	-1	+1	+2	+3	5
Kris	0	+3	0	+1	4
Mana	+1	+2	+2	-2	3
Lizzie	-4	0	+2	+2	0
Nick	+2	-2	+1	-1	0
Billy	**+1**	**-2**	-1	**+2**	**0**

This table (Table 7.5) shows that overall, nine of the 12 students had demonstrated gains in the number of steps they could describe to construct a product, including the food-related items and the fabric, wooden and plastic items. Three students showed no gains, including Billy who was generally unwilling to guess at answers to questions, and Lizzie and Nick whose individual accounts of how products were made were detailed and quite extensive from the outset i.e. directly after the visit to Candyland. The gains which were most noticeable across all the participants data were (i) their awareness of mixing and combining ingredients to create a product and (ii) an increased awareness of the different parts of a product and how these could be created during production.
The losses were linked with (i) a reduced use of context specific language, e.g. moulds, melting and hardening, and (ii) the infrequent reference to details such as spooning or pouring chocolate, and wrapping or packaging the finished product.

Despite the six month time lapse between the completion of the chocolate making unit and the final interview, there seemed to have been an increase in the students' awareness, understanding and possibly experience, of technological procedural knowledge. Over this time, nine of the 12 students appear to have drawn together many of the elements of product development which they have seen or heard about, and by combining these parts have been able to communicate their ideas about the construction of new or unfamiliar items in greater detail.

7.3 Education Outside the Classroom (EOTC)

The focus of this section of analysis is the students' enduring understandings of the purpose of their visit to Candyland. Table 7.6 shows the remaining theme that has been identified and also considered in Chapters 5 and 6. It was of interest in this study to investigate whether the students had retained an understanding about why they went to Candyland and what they had hoped to achieve during their visit. It was anticipated that much of the detail of their experience may have been lost and that the stronger memories of the chocolate and lollipop-making may have subsumed their recollections of the original intent of the experience.

Table 7.6 Students' explanation of the purpose of the visit

Theme
Students' understanding of the purpose of the experience Ability to: • explain the purpose of the visit and link the visit to his or her own technological practice

7.3.1 Memories of visit purpose

Q3 What are students' memories of the purpose of the visit to Candyland six months after the visit?

Section 7.3.1 presents findings related to students' enduring understanding of the nature and purpose of their visit to Candyland. This includes students' perceptions of why they went on the visit and whether they recognised the link between this and their own technological practice of designing and creating a gift for Mothers' Day. The data used to investigate this theme were gathered from the final interviews six months after the visit to Candyland.

7.3.1.1 Students' explanation of the purpose of the visit

Two questions were put to the students at the beginning of this final interview. The first question asked the following: "Earlier this year we went on a trip to Candyland. Can you tell me why we went there?" The second question asked, "Did you have anything special that you needed to find out about during the visit?" The pattern of responses that had emerged in the interviews prior to and immediately after the factory visit appeared to change very little in these interviews. The five students from Oldpark school, with the exception of Kristy, were still quite clear about why they went. These students responded with either, "To know how to make chocolate", "Because we wanted to know how to make chocolate" or "Because we were learning about chocolate". Kristy, who reacted to the strong smell of the lollipops and developed an irritation in her nose, said, "To learn about candy … to find out how to make candy". Her memory of the chocolate-making appeared to have been clouded by her unpleasant reaction to the lollipops. The reasons the students provided when explaining what they needed to find out during the visit had become a little fragmented over time. Four of the students recalled they were making chocolates to give to their parents or to Mum and Dad, and only one student referred to Mothers' Day. In addition, Nick remembered that he made chocolates for Mum, and Rosie was not sure but thought they made them for the teachers or for Mum. There were no links made to Mothers' Day by either of these two students.

The Dayton students' responses were similar to those of their previous interview directly after the visit. Isla understood they had gone to Candyland "because we were learning about chocolate". The four boys provided a range of responses including, "for a little treat", "to look at the candy", and "the teacher organised it and thought it was a good idea". The two remaining students said they "didn't know" why they went. In response to the question which asked if they had found out anything special during the visit to Candyland, interestingly, three of the six students remembered that they went to find out "how they make the chocolate". The purpose of the visit was unclear, but the 'need to know' factor was retained by some.

In summary, and with the exception of Kristy, the students who were clear about the purpose of the visit to Candyland retained their understanding throughout the unit, and up until at least six months later. Similarly, the students who were unclear about the purpose of their visit to Candyland did not at any stage adjust or correct their understandings, despite having designed and made their gifts for Mothers' Day.

7.4 Characteristics of five-year-olds

This final section of the presentation of findings and analysis, aims to investigate two elements of student learning identified prior to the factory visit: (i) students' ability to transfer and apply knowledge, and (ii) their language development, specifically that which relates to the context-specific language associated with chocolate-making. These themes are listed in Table 7.7.

Table 7.7 Themes for analysing the characteristics of five-year-olds

Themes
Language development: Students' ability to use language skills for increasingly complex purposes, i.e. • use a range of context-specific words to create meaning • substitute conventional language with similar known vocabulary to convey meaning (Ministry of Education, 1996; Ministry of Education, 2007)
Transfer and application of ideas Students' ability to: • extend what has been learned in one context to a new context

7.4.1 Students' transfer of ideas and application to a new context

Q5 Are students able to extend what has been learned in one context to a next context?

The data used to investigate this theme was also gathered during the interview six months after the chocolate-making unit with 12 of the original 16 students. Before the visit to Candyland, the students had participated in a range of activities and learning experiences that illustrated and demonstrated the processes involved in product development. They had read books about the origins of the cacao bean and a little of the history and discovery of chocolate as an edible food product. They had then observed the chocolate-making process at the factory and also seen how boiled sweets and lollipops were made. Alongside these experiences, they had participated in the research interviews and were encouraged to think about and describe how a range of products had been made. Section 7.2 describes the overall gains made by students as they attempted to describe how they thought a range of familiar and unfamiliar products were constructed. The analysis of this theme aims to identify whether there was evidence of students drawing on the knowledge and experiences listed above.

In this section, the responses of three students from both Dayton and Oldpark schools are considered and analysed in order to present a detailed picture of a the students' understandings and possible transfer of knowledge across the three phases of this study (see Tables 7.6, 7.7, and 7.8). Dana and Nick from Oldpark School have been selected and Cameron from Dayton school. The responses from these students are representative of the mid to upper range of responses gathered from the 12 participants. There is a full set of rich data provided by each of these students, and distractions of ill-health, or stresses within the families, were not apparent with any of these students. In addition there is a mix of male and female students and students from both of the participating schools.

The first column in the Table 7.8 shows data that reflects information presented at Candyland and the activities and experiences students had participated in at school. This column is headed 'After the visit'. The students' responses may also draw on their prior knowledge.

Table 7.8 Transfer of information to a new context: Example 1 (Dana)

Product	After the visit	6 months after the visit
Chocolate products	Refers to: • ingredients to make chocolate • melting chocolate • using a mould • bulk chocolate – "big block of chocolate" • machinery to melt chocolate • pouring chocolate • coloured chocolate • different shaped moulds • using the fridge as part of the process • different flavours of chocolate • spooning chocolate	Refers to: • melted chocolate to make the chocolates • pouring chocolate • melting marshmallow to pour it into shapes • chocolate fillings – caramel • the different types of chocolate and "normal chocolate" • the different shapes of chocolate – fish, butterflies … • using the fridge as part of the making process
Other products	• using a mould to make the dinosaur (incorrect) • put wood inside the mould (incorrect)	• the jandal user – there is a strap so it doesn't fall off the feet

Dana's responses in the interview six months after the visit showed that many of the key ideas associated with chocolate making had been retained since the interview directly after the visit, and she used these to help describe how the marshmallow-filled chocolate Christmas tree would be made. In addition, many of the concepts which were introduced during the visit to Candyland are apparent within this final interview. Dana discussed melting chocolate, pouring it into shapes, and the use of a fridge to harden the chocolate. In addition, her responses indicated an awareness of the different flavours and shapes which could be created. On the other hand, there was no mention of bulk chocolate, the machinery in the factory to melt the chocolate or the technique of 'spooning' chocolate into the moulds. She had also substituted the word 'mould' with 'shape'. In this example, the key ideas of chocolate making have also been retained although six months later, Lizzie provided a more descriptive and detailed account of her experiences at Candyland. Again, the concepts introduced as part of the visit to Candyland can be seen through the interview data. Lizzie was aware of ingredients, melting chocolate before pouring it into the moulds, the use of appliances to heat and cool the chocolate, as well as the different types of chocolate which were available.

Table 7.9 Transfer of information to a new context: Example 2 (Lizzie)

Product	After the visit	6 months after the visit
Chocolate products	Refers to: • 'cocoa' beans • melted chocolate • a fridge to use in the process • using a mould • spooning chocolate into the moulds • the different shapes of moulds and chocolate • different types of chocolate e.g. milk chocolate	Refers to: • ingredients to make chocolate including sugar cane • a fridge to make chocolate hard • using a mould • using a microwave to 'heat' the chocolate • using the microwave to melt chocolate • bulk chocolate – 'the big block' • 'runny chocolate' to put in the moulds • white, dark and 'real' chocolate • chocolate fillings • the sequence within the process e.g. attaching hundreds-and-thousands needs chocolate that is not too hard
Other products	No obvious connection	Refers to: • making jandals starts with a mixture • the jandal mixture needs to 'get hard but not all that hard' • you need a model to make jandals

In addition, she had noticed the changing state of chocolate during the production of the various chocolate products and appeared to understand the importance of sequence when combining chocolate with other products e.g. adding an outside layer of hundreds-and-thousands.

In this example, Kris appears to have further developed some of his thinking associated with making the chocolate Christmas tree and the two chocolate products which he made himself – the chocolate fish and the Mothers' Day gift. In the interview six months after the visit, he appears to have drawn on ideas presented during the visit to Candyland including mention of 'the big block of chocolate' and the chocolate buttons from which chocolate products are made, as well as the variety of colours, shapes and types of chocolate which can be made. He refers to heating the chocolate before putting it into the moulds, and although there was no mention of machinery in the final interview, he did refer to using a microwave to melt the chocolate and a 'cold oven' to cool it down.

These three tables illustrate the knowledge gained at Candyland that was applied directly after the visit to the students' descriptions of how the Tiny Teddie and the chocolate Christmas tree were made.

Table 7.10 Transfer of information to a new context: Example 3 (Kris)

Product	After the visit	6 months after the visit
Chocolate products	Refers to: • the 'big block of chocolate' • machinery used to make chocolate • using a mould • pouring chocolate into a mould • bulk chocolate – chocolate buttons • different coloured chocolate • different shaped chocolate • different types of chocolate e.g. white	Refers to: • using moulds • heating chocolate before putting it into a mould • a microwave to make it 'soft and squishy' • the need to cool chocolate down • a 'cold oven' to harden chocolate • different types of chocolate – 'plain', milk and white chocolate • fillings – caramel • different coloured chocolate • different shapes • the sequence of process e.g. put chocolate in an oven, take it out, dip the marshmallow in then put on the hundreds-and-thousands
Other products	• Use a mould to make the dinosaur (incorrect) • Use a tray to collect the spare pieces of wood • Put it in a 'dumping room' • Referred to 'God and Jesus' as making all the items of technology – link to 'the Maker'?	No obvious connection

All three students made reference to using moulds, pouring chocolate, and the different shapes and colours of chocolate that were available. These elements of chocolate-making were not discussed in the interviews that took place before the visit. Two students mentioned the use of a fridge as part of the chocolate-making process, and two were aware that the chocolate came in bulk form and was used to create other chocolate products.

Six months later, vocabulary such as ‘moulds’ and ‘melted’ were not used as consistently and confidently as they had been in the previous interview, but the understandings of process appear to have consolidated and, in some cases, extended. Heating chocolate in order to melt it was mentioned more frequently, and, although this was observed at the factory, experiencing the chocolate-making activity at school during which microwaves were used to melt the chocolate, seemed to clarify the purpose of this as part of the chocolate-making process. The detail that these students provided as they described how the Christmas tree might have been made was notable. Most students attempted to reason how the marshmallow would have been positioned inside the chocolate shape and at what point the hundreds-and-thousands would have been used to coat the outside. Dana was aware that the marshmallow may have been heated and melted at some point, and Kris thought it would have been ‘dipped’ into the melted chocolate. As mentioned previously, Lizzie pondered on the sequence in which the hundreds-and-thousands had been added to the chocolate and finally reasoned that they would have been added while the chocolate was still warm – “before it got hard”. These examples all point to the students’ advancing understanding of how each product may have been made. Their descriptions had become more detailed and they were willing attempt a description of a process that they had not previously observed. There is evidence that new understandings gained during the visit to Candyland were used consistently to describe how similar chocolate based products such as the chocolate Christmas tree and the Tiny Teddie biscuit were made.

7.4.2 Students’ language development

> Q4 What is the retention of students’ context-specific language six months after the visit to Candyland?

As in the previous section, the responses from the same three students’ interviews have been investigated to identify the use of context-specific vocabulary that had been introduced by the teachers before the visit, and reinforced during and after the visit. As before, these students were selected because there was a full set of data, a mix of male and female students, and included students from both of the participating schools.

Table 7.11 shows the context-specific words associated with chocolate-making which students used during their interviews after the visit, and again six months after, as well as any approximations or substitutions of this vocabulary which they employed in order to express their ideas.

Looking across all of the data, whilst the students confidently used words such as melted, moulds or harden during the interview directly after the visit, six months later, some of this language was not apparent or was used intermittently. The word ‘mould’ was replaced with words such as cups, round things, a shape tray and the very descriptive “little fish holes”.

Table 7.11 The use of context-specific vocabulary after the visit to Candyland

Name	After the visit	6 months after the visit
Dana	*Context specific vocabulary*: Cocoa, melt, melted, mould, poured, coloured chocolate, caramel *Approximations*: big turning machines, special fridge *Substitutions*: Nil	*Context specific vocabulary* : Cold fridge, melted, pour *Approximation*: Nil *Substitutions*: Nil
Lizzie	*Context specific vocabulary* : Melted, fridge, moulds, spooned, milk chocolate *Approximations*: Nil *Substitutions*: Nil	*Context specific vocabulary* : Hard, heated, microwave, melt *Approximations*: Nil *Substitutions*: Runny (melted)
Kris	*Context specific vocabulary* : Moulds, mixed, white chocolate *Approximations*: Nil *Substitutions*: Nil	*Context specific vocabulary* : *Approximations:* cold thing (cooling tunnel), cold oven (cooling tunnel or fridge) *Substitutions:* Soft, soft and squishy (melted), cooled down (hardened)

The word ‘melt’ received a similar array of substitutions – soft, soft and squishy, not hard, and runny. The students were generally clear about the message they intended to communicate, but some of the context-specific language previously used by the students was now absent. The conversations indicated, however, that once the context-specific word had been used by the researcher during the interview, students quickly incorporated it back into their own spoken language. It appears, therefore, that whilst this language was constantly being reinforced in the classroom or at home, the students were able to confidently and accurately utilise it as part of their every-day speech. When the language was no longer being used, although their understandings of the technological process appear to have been retained, the associated language was no longer included in their conversations.

7.5 Chapter summary

The focus of Chapter 7 has been to ascertain the enduring understandings of the students as they relate to five questions identified at the beginning of this chapter:

The intended learning of the chocolate-making experience was to develop students' knowledge of heating, melting and hardening chocolate in order to construct different shapes, to develop their knowledge of the necessary ingredients, equipment and an understanding of the sequential series of processes required to achieve a successful outcome. The majority of the students, six months after their chocolate-making experiences, referred to these concepts during their descriptions of how the various chocolate-based products were made. Conceptually, these learning intentions were robust and enduring. The students' knowledge of materials and material properties, other than the chocolate-making materials, had undergone a gradual development however the students tended to rely on how the product looked and felt when deciding how it could be manipulated, rather than being able to draw on prior knowledge or previous experiences. Their understandings were limited but they no longer applied what they understood of chocolate making to the plastic and rubber based jandal, as had occurred in the interviews directly after the visit when the wooden dinosaur was discussed.

The students' procedural knowledge showed the greatest advancement over the six months. The 'simmer and brew' analogy (White, 1954 cited inYaden, 2003, p. 348) is a useful way to describe the consolidation of ideas which seems to have occurred over this period. The majority of students were able to describe the construction of the products presented during the interview, with greater detail, and an increased awareness of the individual parts of a product, compared with the descriptions offered in the interview directly after the visit.

With the exception of one student, the students' understanding of the purpose of their visit to Candyland remained unchanged; those students who were able to articulate the information gathering purpose of their visit continued to do so in the interview six months later, and those who were unclear at the outset, remained so throughout the unit and six months later.

The greatest challenge facing students in this final interview, seemed to be remembering the context-specific language associated with chocolate-making. Several students reverted back to the use of approximations and substitutions in order to communicate their ideas, and whilst this impeded the fluency of their descriptions, the ideas which they endeavoured to express were clear and generally accurate.

A final point, and one which is key to this investigation, is whether the five-year-old participants in this study were able to use the knowledge gained during their visit to Candyland to understand and describe how other products may be developed. The analysis of the interview data six months after the visit clearly indicates that the students incorporated elements of the chocolate-making at Candyland into their descriptions of how the chocolate Christmas tree was made. Without specific prompting, they transferred knowledge from what they had learned in one context to a new context.

Chapter 8, the final chapter, discusses the findings from all three data chapters, before the visit to Candyland, after the visit and six months after the visit and draws conclusions for this study.

Chapter 8

Discussion and conclusion

8.1 Introduction

The aim of this chapter is to discuss the findings of Chapters 5, 6 and 7 in light of the research questions and the literature review of this study. Conclusions and implications for teaching five-year-old students when integrating technology with experiences outside the classroom are also considered. A proposal for future research completes this chapter.

The research question directing this study asked how the learning of 5 year-old-students in technology education can be enhanced through experiences outside the classroom. This question has been addressed through the following sub-questions:

1. How can a technology unit for five-year-old students, which incorporates an experience outside the classroom, be planned for?

2. How does a site visit contribute to the learning intentions of a technology unit for five-year-old students, which incorporates an experience outside the classroom?

3. What are the learning outcomes of a technology unit for five-year-olds that incorporates an experience outside the classroom?

4. What enduring understandings do five-year-old students retain from a technology unit, which incorporates an experience outside the classroom?

The technological problem, which was the basis of this unit, required students to find out how to make chocolates for a Mothers' Day gift. The following discussion uses the same organisational structure as the data chapters: (i) preparation for the visit, (ii) organisation and outcomes of the visit and (iii) enduring understandings resulting from the visit. Table 8.1 shows how the sub-questions, the intervention chapter and data from Chapters 5, 6 and 7 are merged and examined.

Table 8.1 Organisation of data discussion in Chapter 8

Section	Content	Data
8.2: Preparation	Research sub-question 1 (planning)	Chapter 4 & 5 (Intervention and data chapter before the visit)
8.3: The Visit and Outcomes	Research sub-questions 2 & 3 (intentions and outcomes)	Chapter 4 & 6 (Intervention and data chapter after the visit)
8.4: Enduring Understandings	Research sub-question 3 (enduring understandings)	Chapter 4 & 7 (Intervention and data chapter 6 months after the visit)
8.5: Conclusions		
8.6: Recommendations		
8.7: Final comments		

8.2 Preparation

8.2.1 Introduction

This section aims to explore the first research sub-question: How can a technology unit be planned for five-year-old students, which incorporates an experience outside the classroom? As shown in Figure 8.1, it draws on data from Chapter 4 (The Intervention Model) and Chapter 5 (Findings 1: Preparation for the visit). Chapter 4 describes the planning model, which, informed by the literature review for this study, explains the process by which the teachers and I co-constructed both the technology unit and the students' visit to Candyland. It was necessary to consider not only the role of the students and teachers, but also the parent-helpers, the factory staff and the factory presenter. Chapter 5 analyses the student data gathered before their visit to Candyland in which their prior knowledge of chocolate-making and their attitude towards the visit were investigated.

8.2.2 Teachers' preparation and planning

The teachers participating in this study were naturally responsible for the overall management of the technology unit and the visit outside the classroom. As part of this role, they needed to plan for and prepare the students, parent-helpers and the factory staff, as well as giving thought to their own preparation and the role they intended carrying out. This was a multi-layered and complex undertaking which is summarised in Table 8.2 below and discussed in the following sections.

<table>
<tr><th colspan="9">Planning and teaching sequence</th></tr>
<tr><td colspan="2">Weeks 1 & 2</td><td>Week 3</td><td colspan="3">Week 4</td><td colspan="3">Week 5</td></tr>
<tr><td>EOTC</td><td rowspan="2">Teacher unit planning and visit prepara-tion</td><td>Liaise with and prepare parents for their role in the visit</td><td>Prepare students for visit</td><td rowspan="2">Visit factory</td><td rowspan="2">Follow-up factory visit with</td><td colspan="3">Connect final three phases to students' knowledge gained during the factory visit</td></tr>
<tr><td>Technology</td><td>Liaise with and prepare parents for their role in the technology tasks</td><td>Prepare students for tech-nology task</td><td>Facilitate market research and design process</td><td>Facilitate chocolate-making process</td><td>Facilitate review and reflection of design and construction process</td></tr>
</table>

Figure 8.1 Model of planning merger between EOTC and Technology Education

The findings of this study clearly indicate that subject knowledge of the technology curriculum and the way in which EOTC can be used to enhance student learning is key to the classroom teachers' management of a unit. Anderson et al. (2000) emphasised the same point, noting that teachers must identify specific curriculum objectives when taking students on an experience outside the classroom, as in a well-considered and carefully planned unit of work, the benefits for the students are greater. The co-construction process led to a teaching unit that contained clearly defined learning intentions based on the achievement objectives of the technology curriculum (Ministry of Education, 2007b). The clarity of the teaching goals enabled the teachers to share the learning intentions with their students, the parent-helpers and the factory presenter. This enabled all those involved to work toward the same ends.

The summary of initial planning discussions held with the teachers prior to the visit indicated that, as experienced teachers, they had extensive organisational knowledge of EOTC – they knew what worked well and, pedagogically, they knew how to achieve their teaching and learning goals (Section 5.2.1). They brought a great deal of practical and curriculum knowledge to our discussions, confirming much of what was presented in the literature. The challenge for them was to align this with the detail of the technology learning area in *The New Zealand Curriculum* (Ministry of Education, 2007b) and establish clear links between the preparation tasks of the pre-visit phase, the visit and the post-visit activities. By sharing our combined knowledge of the curriculum we converged these three phases into a planning framework. This aimed to provide students with the knowledge and skills that, supported by their teacher, would enable them to respond to the task with an appropriate technological solution.

A second critical element to be considered was the selection of an appropriate site to visit, and this required reference to a number of factors highlighted in the literature. Wineman, Piper and Maple (1996) advocate for the selection of age-appropriate sites i.e. those that capture the interest of the students, and provide experiences in which they can confidently engage. Falk and Balling (2001) advise selecting sites of “appropriate novelty” (p. 28), which offer new, interesting and clearly discriminatable activities, and which are not complicated by the distraction of irrelevant stimuli. Complementing this view is that of Deaker (2006) who identifies that first-hand, concrete experiences are invaluable aids to student learning, and sites that offer authentic, hands-on and interactive engagement with exhibits can result in enhanced student learning. Rennie and Johnston’s (2004) research suggests that when these factors are in place, a visit can be particularly memorable and enable students to recall key aspects of the visit a long time afterwards. Candyland offered many of these characteristics. The field notes and student interviews before the visit to Candyland indicated convincingly that the chocolate context was very appealing. Candyland was to be a novel experience for 14 of the 16 students, and the hands-on activities to be included in each presentation at the site were expected to benefit students’ understandings and memory of the processes involved in creating a chocolate product.

The visit to Candyland was planned for the morning only. Transport to the factory was expected to take 25 minutes and the factory tour approximately one hour and 30 minutes. The students were to return to school in time for their 12.30pm lunch break followed by a post-visit task in the afternoon. The timeframe of a visit outside the classroom is very important, and particularly so for five-year-old students. The planning for this visit was based on the notion that young students may gain more value from very short forays away from the classroom, as opposed to the usual ‘day trip’, and from trips where learning is to be the primary intent of the day rather than one which is purely recreational (Falk & Balling, 2001). A site with a physical environment that provides easy access to rest rooms and time-out spaces where the students can gather and relax for a refreshment break is a common-sense consideration but one that is supported in Falk's Contextual Model (2004) in which he identifies the physical characteristics of a site that he believes are conducive to students' learning experiences outside the classroom. Addressing these factors at the planning stage added to the enjoyment and ease of access for the parents, staff and students participating in the visit.

8.2.3 Student preparation and planning

In their paper investigating the field trip environment, Falk and Balling (2001) remind us that when considering visits outside the classroom, "developmental differences between children could result in different behaviours" (p. 23). This refers to the varying ability of students to cope with the demands of a novel event, to focus on gathering information, and to manage the distractions of other exhibits. This is a challenge faced by all teachers but was particularly testing within this study when attempting to identify and plan for behaviours that are characteristic of five-year-old students.

There are several generic understandings upon which this chapter rests and which are presented in this section. Firstly, and most importantly, is that learning is contextualised; it occurs within a specific context and is influenced by the personal, social and physical needs of the learner (Rennie & Johnston, 2004). The literature of EOTC supports the notion of real-world contexts and real-world experiences and Dierking et al. (2003) argue that, "Much of what people come to know about the world derives from real-world experiences" (p. 109). This view appears to form the basis of the Ministry of Education's philosophy of Education Outside the Classroom, which advises that real-world experiences linked to students' studies within the classroom can significantly impact on their long-term learning (Alton-Lee & Nuthall, 1990) and "can support the aspiration for broad and deep learning in real-life contexts" (Ministry of Education, 2011, p. 9). Herein lies the value of learning experiences outside the classroom in technology education, particularly as it relates to seeking the practice of experts relevant to the students' studies and progressing students' technological literacy. This study, where students investigated the practice of expert chocolate-makers at Candyland, aligns with this philosophy.

The influence of prior knowledge on student learning and the resulting ability of students to transfer these understandings to a new context was an important consideration in the planning and preparation phase of the visit to Candyland. Furthermore, McCormick (2004) argues that problem-solving skills, which are an essential part of students' technological practice, depend on considerable domain knowledge. So in order to facilitate students' familiarity with the context of making chocolates, the teachers read stories about the origins of chocolate, the process involved in making chocolates and further developed language that was relevant to the context. This view is supported by Pinkham et al (2012) who argue that prior knowledge of a context allows for easier engagement with that context and new understandings are more likely to be remembered if they are associated with what is already known. These views were central to the planning of the EOTC experience in this study because, although the primary function of students visiting the site was to inform their own technological practice, effective preparation would enable students to engage readily with the context, and new knowledge could be remembered and utilised with greater ease.

The analysis of students' prior knowledge gained from the interviews and drawings carried out before their visit to Candyland identified several instances where students drew on their previous understandings in order to answer a question or to complete a task. This validates the time given to preparing students for a visit outside the classroom. The data indicates that the students were all familiar with the context of chocolate-making. They were well-positioned to engage confidently with the context and to build on their existing knowledge of chocolate and chocolate-making during the visit. They were able to name a number of ingredients, materials and items of equipment, and a small number of students were able to draw on their 'funds of knowledge' (Gonzalez et al., 2009) and describe how they thought the chocolate frog, the academic bear and other items might be made. Their ideas, although uncritical, appeared to reflect their pre-school experiences at home with their families or within an early childhood facility. Most students, however, attended only to materials, confirming that young children begin to solve technological problems by exploring materials, and struggle to anticipate the processes necessary to convert these into a final product (Fleer, 2000).

A third feature, which was important in students' preparation for their visit, was the development of their oral language. Oral language plays a significant role in students' thinking and learning. The on-going development of context-specific language allows them to increasingly engage in discussions, ask questions, and refine their ability to listen and understand the spoken language of others. This study recognised that students' language development was fundamental to their engagement in the chocolate-making context and, as a result, the teaching of context-specific vocabulary was embedded into the content-area instruction prior to the visit to the factory. This provided them with the tools to talk and think about the chocolate-making context (Bodrova, 2003; Krause et al., 2003). In the analysis of data in Chapter 5 of this study, the language development of students was considered in terms of topic-specific language, the use of substitutions, approximations and high frequency vocabulary. The students' oral language prior to the EOTC visit generally incorporated a very limited use of context-specific language, with a reliance on substitutions to express their ideas and some use of personal content language. With prompting, some students were able to describe a simple series of steps required to make the academic bear or the chocolate frog and usually demonstrated a beginning awareness of sequence. Whilst the students were able to ask questions relating to their personal needs, they required the support of their teacher to formulate higher-level questions for the presenters at the factory. This unwillingness or inability to ask higher-level questions implied that many of the students were not yet able to use oral language to clarify their thinking or challenge existing assumptions – two important characteristics of problem-solving and design in technology. The task of asking questions in order to gather the information they required, therefore, necessitated the support of an adult, and appeared to position their language competence on the edge of their capabilities – their zone of proximal development (Vygotsky, 1994).

A final element in this preparatory phase of the study, which proved to have a significant impact on the students' final outcomes, was their understanding of the purpose of the visit to Candyland. Young children have a tendency to consider a problem in separate parts without always connecting them coherently (Fleer, 2000) and as the main source of their investigation, it was vital they understood the goals of their visit. Part of the planning for the visit, therefore, included fostering a ‘need to know’ factor so that students were armed with an authentic research purpose, i.e. to find out how to make chocolates. Piaget described the 4–7-year-old child as one who viewed the world mainly from his/her own perspective causing him/her to ignore important information (Piaget, 1954). It is this tendency to ignore important information that becomes problematic for the five-year-old student seeking information about technological practice from experts. To accommodate this, the teachers planning incorporated the support of parent-helpers whose task it would be keep the students focused on the information-gathering goals of the visit.

8.2.4 Preparation of parent-helpers

When teachers plan to take their students on a visit outside the classroom, safety issues are naturally an important consideration. The Ministry of Education safety guidelines regarding adult to student ratio during a visit away from the classroom require teachers to gain the assistance of competent adults who can help supervise the students during all phases of the visit (Ministry of Education, 2011). In this study, however, the supervisory role was extended to incorporate greater emphasis on facilitating learning, rather than simply ensuring the students were kept safe and well-behaved.

A key driver in this decision was the extensive body of knowledge that advocates the benefits of students working in small groups. Interestingly, Griffin and Symington (1997) pointed out that, regardless of how teachers organise their classes, the students naturally break into small groups, preferring to move, talk and work together. The plan in this study was for each parent-helper to be responsible for three or four students, and for the classroom teacher to maintain an overview of the students, parent-helpers and factory presenters. Price and Hein (1991) concluded in their study that the advantage of students working in small groups was that it enabled them to ask questions more readily, receive answers and be more involved in their learning. Gilbert and Priest (1997) highlighted the value of including adults on a visit who had a sound knowledge of the context, which they could share with the students in their care. Accordingly, when preparing for the visit to Candyland, parent-helpers with knowledge of the site and a familiarity with the learning goals of the visit were organised to work with small groups of three or four students throughout the factory tour.

The organisation of small groups naturally facilitates enhanced conversations and Fivush et al. (2006) draws attention to what they describe as 'event talk' – the naturally occurring talk that takes place between a child and a parent around an event. Reese and Newcome (2007) found that there was a link between parents who talk to their children in a richly detailed manner and the extent of information that children are able to recall of particular events. This 'talk' became an important part of the parent-helpers' role. Within the learning intentions of the teaching unit, the aim of the visit was to develop students' conceptual, procedural and technological understandings as well as to ascertain their societal understandings. Accordingly, the parent-helpers were encouraged to introduce and consolidate new vocabulary as they steered their group of students through the factory. Items such as the equipment used in making the chocolates, the ingredients, the moulds and the machinery were to be pointed out to the students. The parent-helpers were also encouraged to simplify the language used by the presenters if they considered it to be too difficult for the students to understand and to highlight the phases of product development. It was hoped that this shared narrative between the adults and the students would enhance the students' learning during the visit and help shape their memories and recall of information at a later state.

8.2.5 Preparation of factory staff and presenters

By communicating with the presenters at Candyland prior to the visit, I was able to negotiate an extended presentation of the chocolate-making workshop. After an initial email and visit to meet the staff at the factory, a follow-up letter was sent to Lance, the factory presenter, informing him of the age-group of the students, and a description of the research project and the teaching unit that was planned for the students. My field notes recorded after these meetings indicate that this was received with interest, enthusiasm and a genuine willingness to contribute to the research project.

8.3 The visit and the outcomes

8.3.1 Introduction

This section aims to explore the second research sub-question: How does a site visit contribute to the learning intentions of a technology unit for five-year-old students incorporating an experience outside the classroom? It also includes a discussion based on the third research sub-question: What are the learning outcomes of a technology unit for five-year-olds that incorporates an experience outside the classroom?

This first section draws on data from Chapter 4 (The Intervention Model) and Chapter 6 (Findings 2: The visit). It responds to sub-question 2 and is organised under three headings: 8.3.2 Teachers' contribution, 8.3.3 Parent-helpers' contribution, and 8.3.4 Factory staff contribution. This is followed by Section 8.3.5, the learning outcomes resulting from the visit to Candyland, which responds to sub-question 3.

The visits to Candyland by the two New Entrant classes generally attained the goals established in the technology unit. The teachers performed their roles with considerable expertise and captured a large number of photographs for use in the classroom afterwards. The analysis of data indicates that students were interested and well-engaged throughout the duration of the visit, with brief periods towards the end of the chocolate-making presentation when a small number of students in the first class visit became distracted. The interviews with these students directly after the visit suggested that the presentation was too long and some of the language was difficult to understand. Having to wait for their turn to make the chocolate fish also caused some students to become restless. In light of this data, the presenter modified his organisation for the second class of students, simplifying his language, and bringing in another staff member to help streamline the students' hands-on task of making a chocolate fish. This resulted in a shorter, more focused session and one that worked better with this group of five-year-olds.

In order to stem hunger-pangs and to avoid being distracted by the tempting but unavailable display of chocolates in the factory shop, the students were given morning-tea on arrival and time was provided for them to use the bathroom and 'stretch their legs' before the factory tour began. Griffin (2004) draws our attention to the Museum Visitors Bill of Rights (Rand, 2000) in which a visitor's comfort is listed alongside their enjoyment, learning, and the challenges experienced during a visit. She maintains that addressing these dimensions is as important during a school visit as it is for adult visitors (Griffin, 2004).

8.3.2 Teachers' contribution

As outlined in Section 8.2.3, the students embarked on the visit to Candyland having been exposed to the origins of chocolate, and an introduction to context-specific vocabulary and the processes associated with the production of a chocolate product. Whilst one class of students appeared to have had a clear understanding of the purpose of their visit, the other demonstrated a limited understanding of why they had come to Candyland. Anderson (2003) argues that the motivation and purpose for visiting an exhibit will impact on what students learn and how much they learn. From the outset, therefore, it is reasonable to expect that differences in the extent of student learning may be revealed as the teaching unit progresses. This made it important for the intervention to include reinforcement regarding the purpose of the visit immediately on return to the classroom in order to draw on the fresh memories of the students.

The teachers' role during the visit to Candyland was to oversee the visit – to manage starting and finishing times, the general movement of students through the factory, and to deal with any problems that arose. Being unencumbered by student supervision, the teachers were able to observe student/parent interactions and their engagement with the site and its exhibits. This enabled them to gain an overview of the students' experiences during the visit and they reported that this helped them provide more effective follow-up activities afterwards. Seifert explains that the way in which knowledge is represented affects the "completeness of memory" (Seifert, 1993, p. 13) and by observing a child's experience and understanding how it may be being committed to memory, a teacher is better positioned to facilitate the child's recall of the experience at a later time (Seifert, 2006).

A further aspect of the teachers' role during the visit was to support and encourage parent-helpers in carrying out their tasks. Rose and Hannah, the participating teachers, both indicated during their interviews that there was significant value in the parents being fully informed about their role during the visit and understanding the learning goals and expected outcomes of the technology unit. Schauble et al. (2002) report that, unless consideration is given to helping the helpers, i.e. the parent-helpers, the energy and resources provided to deepen a student's experience may be unproductive. The preparation of parent-helpers prior to the visit to Candyland clearly utilised their skills to best advantage. In her interview, Rose said she felt the parent-helpers understood the visit was more than "just entertainment" (Section 6.4.1) and the information card they had been given beforehand clearly guided their conversations with their group of students. Cox-Peterson et al. (2003) offer further support to this viewpoint and conclude that by organising the visit around small groups of students accompanied by a more knowledgeable adult, significant benefits to student learning may be achieved. My field notes recorded small groups of animated students speaking freely with the parent-helpers during the visit, staying in close contact and generally remaining well-focused on the exhibits and presentations that were offered.

A final element of the teachers' role during the visit was to photograph all phases of the visit for use during follow-up activities. The literature indicates several advantages in providing a visual record of the experience, some of which are discussed under sub-question 4 in Section 8.3.5. Primarily the visual record was intended to help facilitate discussions, make links between the displays, the presentations and the technological outcome that was to result from the visit, or as described by Griffin and Symington (1997) between the exhibits and the ideas.

8.3.3 Parent-helpers' contribution

The parent-helpers' contribution to the visit was pivotal to the students' meaning-making of the context and their technology task of making chocolates. In retrospect, the impact was far greater than was realised at the time. Elements of Falk and Dierking's Contextual Model (2000), which they argue are fundamental to learning in a museum i.e. the personal, the sociocultural, and the physical context, also help articulate the role of the parent-helper during an educational experience outside the classroom. The parent-helpers in this study were to be motivators, to have expectations of student learning, to act as mediators between the students, the exhibits and the demonstrations, and they were to reinforce, and at times translate, the conversations held between the students and presenters; (Falk & Dierking, 2002; Griffin, 2004). These types of interventions during the visit are known to support the development of knowledge both in terms of amending existing misconceptions, as well as presenting new knowledge (D. Anderson et al., 2000). Young students are limited by their existing knowledge, and in order to accurately interpret an event such as the visit to Candyland, the support of a more knowledgeable adult is essential (Tofield et al., 2003).

The interviews with teachers Rose and Hannah confirmed that these types of interactions between the parent-helpers and the students occurred during the visit to Candyland. In particular, Rose noted that the parent-helpers with her class understood the visit was to inform the task occurring after the visit, and she felt they took the role seriously – talking to the students, pointing out items of interest, naming items correctly and generally interacting with the students in a positive manner. As parents they were naturally familiar with the age-group of the students, they knew their interests and they understood how to interact with them. The students all indicated in their interviews that the visit to Candyland was a good experience – some saying they felt happy or that it was exciting. This was confirmed by my observations of each class visit and during discussion with the two parent-helpers after the visit, which indicated that the students enjoyed a relaxed and entertaining experience.

The importance of enjoyment during a visit is corroborated by Anderson et al. (2003) who concluded that enduring and valuable learning outcomes result from enjoyable visits (to museums, in their case). When they are enjoying themselves, the students tend to be more interested and are more likely to have a positive attitude towards the activities offered during the visit. This, according to Anderson et al. (2003), results in learning outcomes that are enhanced. There was evidence of this in the student data collected directly after the visit. The students' knowledge of chocolate and chocolate-making had made gains, and their descriptions included greater detail and accuracy of both the process of product development and their knowledge of equipment and ingredients. The opportunity to view chocolate-making first-hand appears to have had a significant effect on their conceptual, procedural and technical development. Sequencing a small number of steps in production proved to be well-established with the students. However, the uncritical transfer of these understandings to the development of other products indicated a limited knowledge of material properties other than those that were part of the chocolate-making process. Similarly, the concept of heating and cooling, and the changing state of matter as it relates to making chocolates, was better understood after the students had visited the factory. There were fewer misconceptions recorded during their interviews and in the analysis of their drawings and stories. By observing the melting tanks and the resulting 'chocolate waterfall' of melted chocolate during the visit, and then using the liquefied chocolate to pour into the fish moulds, the students were able to articulate the importance of heating and cooling materials in order to fashion new shapes and products from the previously solid bulk chocolate. Whilst they were unsure of what happened to the chocolate fish once it was placed on the conveyor belt and travelled into the cooling tunnel, they were clear that the fish hardened before they were wrapped. This again relates to the work of Rennie and Johnston (2004) and Deaker (2006) who argue that when elements such as hands-on activities are included in an experience outside the classroom, student understandings, and the richness of their memory of events, are increased.

A final point of interest in this section is the students' developing understanding of the role household appliances such as a fridge and an oven or microwave play in the heating and cooling of materials. Before the visit, the students seemed to connect creating a food product with the use of an oven. This, as with material properties, was an uncritical connection and they were generally unable to discriminate between the heating function of the oven and the cooling function of a fridge. After the visit, this ability to discriminate appeared to have been increased. Microwaves and ovens were generally associated with melting chocolate and the fridge associated with cooling or hardening the chocolate.

8.3.4 Factory staff contribution

The skills of the principal factory presenter, Lance, were an added bonus during the students' experience at Candyland. The parents, teachers and students all commented on his good humour, his patience and his ability to engage the students. He was amenable to taking part in the research and, as a result of our prior negotiations, was willing to make alterations to his usual presentations for the benefit of the students and their goal of making chocolates for Mothers' Day. We know that many learning theorists have recognised the role that concrete experiences with real objects play in student learning (Gredler & Shields, 2008) and Lance incorporated many items and examples of these into his presentation. However, when working with young students there can be a perception that technical terms are beyond their comprehension and it was noted by one of the parents that, in order to simplify the presentation, Lance occasionally substituted less complicated names for equipment rather than use the technical term. This prevented not only the students hearing and using the correct terms but also the parent-helpers. An improved strategy may be to use the technical term but explain it by including a more descriptive term, for example, the extruder and the chocolate waterfall.

The activity that the students recalled with the greatest clarity was the hands-on activity, which Lance offered during the chocolate-making presentation. The students were able to individually spoon chocolate into a small fish-shaped mould, and once cooled and hardened, they were able to be take the chocolate fish home. This style of presentation aligns well with much of the literature outlined in section 8.3.3, particularly the connection between hands-on experiences and students' long-term memory of events (Deaker, 2006; Rennie & Johnston, 2004). In addition, Lance was able to reduce the complex ideas of chocolate-making down to a level the students could understand and, through the combination of demonstration, discussion and the hands-on component, he was able to provide an interesting and varied presentation (Cox-Petersen et al., 2003; Moreland et al., 2005). His specialist knowledge and skills provided examples of technological practice other than those the students could have gained at school and this added to the overall significance and benefit of the visit.

8.3.5 The learning outcomes resulting from the visit to Candyland

In this section the third sub-question is explored: What are the learning outcomes of a technology unit for five-year-olds that incorporates an experience outside the classroom? The section is again organised into two sub-sections, 8.3.5.1 Teachers' contribution, and 8.3.5.2 Parent-helpers' contribution.

8.3.5.1 Teachers' contribution

The literature review revealed some valuable theories about the retrieval of young students' memories and how these can be manipulated and altered by outside influences so a child can imagine that events have occurred when in fact they have not (D. Cohen, 2013; Siegler & Alibali, 2005). It is also reported by Bruck and Ceci (1999) that incidents that occur shortly after an event undoubtedly impact positively on the retrieval of memories. In a similar project, Rovee-Collier (1995) identified a “time window” (p. 238) – a period within which children’s memories of an event will be strengthened if it is repeated, and particularly if this repetition occurs towards the end of the time window when their memory is beginning to weaken. The duration of this is determined by when the child would forget the initial information (Siegler & Alibali, 2005). These ideas were introduced into the initial planning discussions and they influenced the selection and timing of students’ activities directly after the visit. For example, the students in both New Entrant classes were invited to draw pictures describing their experience at Candyland as soon as they returned to school. Over the following days they were encouraged to write stories, participate in class conversations and review the photographic record collected by their teacher during the visit, all with the intent of clarifying and consolidating their interpretation and memories of the visit.

The learning outcomes achieved by the students were significant. The data that were analysed after the students had constructed their chocolate gift indicated that there was a substantial increase in their knowledge and use of context-specific vocabulary i.e. the ingredients, the equipment and the machinery associated with making chocolates. Contemporary research into language development is consistent in the view that central to all development is the acquisition of language, and theories specific to the development of a child’s oral language make a clear link between a student’s vocabulary, comprehension and conceptual knowledge development (Wright, 2012). After their visit to Candyland, the students in this study had noticeably extended their understanding and use of context-specific words into their everyday speech. Their earlier tendency to use substitutions or approximations to express their ideas had diminished by the end of the teaching unit. Their awareness of the association between process and the function of machinery had increased, and it was clear in their interviews after the visit that for many of them machinery carried out specific functions rather than having a generic all-purpose function. After the visit they were able to either name the machines correctly or incorporate descriptors that described how they functioned. This is an example of the very broad concept that children initially develop, then revise and restructure over time (Seifert, 2006). Piaget referred to this as the development of cognitive structures, ‘schemes or schemas’, which he expressed as a mental image or cluster of related ideas used to organise existing knowledge and to make sense of new experiences (Krause et al., 2003; Nutbrown, 2011). By comparing the data collected before and after the visit to Candyland, a definite change in the way the students conceptualised machinery was illustrated.

Baddeley (2012) draws our attention to visuospatial information – one of two systems of the working memory, which includes the encoding of nonverbal, spatial, and visual information. The visit to Candyland was a highly visual and rich sensory experience and the students' working memory was flooded with visuospatial information. This, alongside language-based information, provided a very rich source of new knowledge supported by clear visual memories. The nature of these experiences goes some way to explain the gains in students' understanding of procedural knowledge – knowledge of how to construct a product, the materials to use and how to successfully accomplish its intended function (Baird, 2002). Prior to the visit, the students described a very limited number of steps in a technological process, and their focus tended to be on the ingredients and equipment required to make the product. After the visit, the same students were able to describe several more steps in a process with greater attention given to the phases of development and a beginning awareness of material properties. Moreland and Cowie (2011) discussed this as students' understanding of the continuity and connectedness of the tasks within technological development and realising that each task was one step in a more extensive process, rather than being an end-point in its own right. This was demonstrated in the functional models the students created. The rationale behind including functional modelling in the teaching unit was intended to help the students draw together the information they had gathered at Candyland, i.e. being able to select the colours, shapes and flavours of their chocolate gift and to combine these ideas with the results of their questionnaire.

Previous research investigating young students' design drawings concluded that young students lack the ability to make a connection between their design drawings and the construction of a final product (Fleer, 2000; Rogers & Wallace, 2000). This study found that, in general, the students were able to give a simple but reasonable explanation for creating models of their chocolate gift. The purpose of a functional model was listed in the unit plan as a specific learning intention, and three-dimensional clay or Plasticine models were selected as suitable media for students to communicate their design ideas. These decisions resulted from the work of a number of researchers who support the theory that young children struggle to model a three-dimensional object using a two-dimensional medium (Mawson, 2007; Stables, 1997). The analysis of data concluded that by using a three-dimensional medium, students were able to construct a simple but easily recognised model of their chocolate gift, which allowed them to consider all faces of the structure rather than being restricted to a typical two-dimensional frontal view only. More importantly, most of the students revealed through their interviews that they were beginning to see the interconnectedness of the stages in the design process. Most students understood there was a purpose for creating the models, and generally described this as helping them prepare for making their chocolate gift.

The students' developing ability to transfer their understandings of technological processes to new contexts was another factor that was demonstrated in their interviews after the visit, although at times, where the task related to products other than chocolate-based products, this was uncritical and confirmed their limited knowledge of materials and material properties. De Vries (2012) alluded to this behaviour, arguing that technological knowledge is very context-specific and less likely to be generalised because of the individual nature of each design problem. The five-year-old students' limited experience of technology and technological knowledge makes the transfer of their newly acquired understandings particularly challenging and this was illustrated in the initial confusion some students had regarding how materials such as wood could be shaped.

8.3.5.2 Parent-helpers' contribution

Teaching technology to five-year-old students invariably requires the assistance of teacher aides or parent-helpers. In this study, a group of parents was invited to attend the visit and also to assist the students when they made their chocolate gift. Whilst the parent-helpers' role of facilitating learning during the visit to the factory was well considered and thoroughly prepared, less attention was given to their role of supporting the students when they made their chocolate gift. An underlying assumption was that parents assisting during the visit would be the same as those attending the chocolate-making session. However, although the parent-helpers from Oldpark School were the same for both sessions, those from Dayton School were different. This latter group of parents had not participated in the parent-helpers' meeting before the factory visit, had not experienced chocolate-making at the factory and had a limited understanding of the purpose of the final technology activity and the connection it had to previous tasks. It was not surprising, therefore, that they overlooked a number of important elements of the activity. Siegler and Alibali (2005) remind us that young students store the gist of events they experience and at times fail to absorb important details. Moreland and Cowie (2011) describe the importance of ensuring students maintain a sense of continuity and connectedness as they work through the phases of technological practice. The students' practice at this critical phase required the support of the teacher and the parents as they needed to bring together several key components – the results of their questionnaire, their chosen design and something of the knowledge they had gleaned during their visit to Candyland. Without a clear understanding of the nature of this series of technological tasks, some parents were unable to provide the support that was required.

We understand from Mitcham's (1996) research that the values that individuals attach to an artefact impact on the resulting interest, motivation and acceptance that is generated. We also know that students' practice in technology is strongly influenced by the subject knowledge of the teacher and, in this case, the existing knowledge of the parent-helpers. The parent-helpers, at times, made decisions about how the students should create their chocolate gift without, as mentioned above, an appreciation of the research and design tasks which were intended to inform this final task. This was particularly noticeable with the parent-helpers from Dayton School who were not present at the original briefing. They drew on what they knew about chocolate-making and offered students options that they thought were appealing and would enhance their final outcomes. Seifert (1993), Siegler and Alibali (2005) and many other scholars in the field of educational psychology stress the difficulty students experience when distractions interfere with their thinking. When a parent-helper at Dayton School offered students the choice of making a chocolate for themselves, as well as one for their mother, this created an unintentional distraction for the students and some students lost sight of the real purpose of this final task. This slight change of direction resulted in two students making chocolates that they liked and their mothers did not, one student who ate his chocolates before he went home, one who ate his when he got home, and one who mysteriously lost his at the after-school care programme.

Similarly, when a parent-helper at Oldpark School offered students a choice of colourings to use, other than those the students had identified from their questionnaires, interfering information (Seigler & Alibali, 2005) again distracted some students from persisting with their chosen chocolate design. Barry (2006) describes this as a 'competing demand', which interferes with a child's ability to process and store information. Towards the end of the session when everyone had lost a little of their original enthusiasm, some colourings were no longer available and the remaining students needed to choose from what was left. These changes, although well-intended, failed to take advantage of the student's previous practice and build on what Mitcham (1996) describes as the notion of technology as activities – an interlinking process of designing, making, and using and/or appreciating processes (de Vries, 2012). For some students an important connection had been lost. Fortunately there were also many successes and these tended to result when the parent-helpers *were* mindful of the information-gathering tasks that led up to 'the making day', when there were no time constraints, and when resources were still plentiful.

8.4 Enduring understandings 6 months after the visit

8.4.1 Introduction

This section aims to explore the fourth research sub-question: What enduring understandings do five-year-old students retain from a technology unit, which incorporates an experience outside the classroom?

A specific focus within this study was to structure student learning so that the students' memories of the visit to Candyland would be clear, enduring, and would provide understandings that the students could draw on when faced with technological challenges in the future. This section of Chapter 8 draws on data from Chapter 7: Findings 3: Enduring Understandings, which analysed student interview data gathered six months after the visit to Candyland. Chapter 7 presented an overview of the students' knowledge and understandings of chocolate-making, which were developed before, during and after the visit to

Candyland. In addition, the chapter investigated the students' ideas about how a product, unrelated to the chocolate context, might be made. In this case a toddler's jandal was selected. As previously, this section discusses the findings of Chapter 7 and how they align with the literature, and the data gathered during the final interviews with the students. It is presented under four headings: student interest in the chocolate-making context, students' language development, their development of technological concepts, and the ability of five-year-olds to transfer knowledge and understandings to new contexts.

8.4.2 Student interest in the context of making chocolates

Six months after the chocolate-making task, the teachers reported that their students had shown on-going interest in the chocolate-making context with several students reporting on pictures, stories, television advertisements or experiences they had had at home making chocolates. This interest carried on for several months after the conclusion of the teaching unit. The importance of student interest in a context and the connection with their recall of an event has been a key factor in the literature of EOTC since the early 1980s specifically that which relates to planning visits (Falk & Balling, 2001; Falk & Dierking, 2000; Hudson, 1983). The students' extended interest in chocolate-making, particularly those students from Oldpark School, appears to have become self-perpetuating. The television advertisement showing at the time, which referred to the discovery of the cacao bean and its chocolate-making properties, became a regular reminder for the students, and the students' enthusiasm prompted several parents to experiment with making chocolates at home. Books and magazine articles about chocolate were brought to school, and on-going snippets of information were shared during the daily news time. At the time of the final interviews six months after the visit, the chocolate-making context appeared relatively fresh in the minds of several students.

8.4.3 Language development

Language development played a very important role in this study. Section 8.2.3 comments on the significant development of students' context-specific language once their chocolate gift for Mothers' Day had been completed, but the subsequent question was how enduring was the use of this language six months later. Analyses of data collected in the interviews with students six months after the visit to Candyland indicated that, whilst the students were generally clear about the message they intended to communicate, some of the context-specific language was absent and some students again resorted to using substitutions and approximations to convey meaning. Once the context-specific vocabulary had been re-introduced by the researcher, however, the students quickly incorporated it back into their spoken language. The concepts associated with the context-specific language were robust, but the infrequent use of vocabulary associated with these had, over time, been forgotten and was no longer part of their every-day language. Wright (2012) emphasised the importance of not only including "rich and explicit explanations of words," and the teaching of words within context, but also the "review and practice" of words (p. 149). This was achieved during the block of time dedicated to the teaching unit, but once this was completed, the on-going review and practice no longer occurred. The earlier reference to the language competence of the adults and peers in the lives of the students, and the impact this has on their learning, is also relevant here. When the teachers, parents and students stopped talking about the visit and the chocolate-making experience, the previous language, which had become so familiar to the students, gradually slipped from their repertoire (Connor & Morrison, 2012; Wright, 2012). The research of Coyne et al. (2009) also found that exposure to words outside the original context advantaged young students' knowledge of words, and the on-going repeated exposure to words after the event that was embedded into Wright's research is a practice that may have benefitted the five-year-old students in this study.

8.4.4 Students' knowledge development in technology

One of the desired outcomes of the 2007 New Zealand technology curriculum (Ministry of Education, 2007a) is the development of a range of conceptual and procedural understandings. It was apparent that during the pre-visit phase of the teaching unit, students had acquired knowledge about the context of chocolate; how it was created from the cacao bean, the different types of chocolate that were available and some of the language associated with making chocolates. At this point in the teaching unit, little was understood about the process involved in making a chocolate-based product.

Ryle (1945) conceptualised the distinction between ‘knowing what’ and ‘knowing how’, in other words, knowing the steps to take and the materials to use in order to create an item that could carry out its intended function. Baird (2002) describes that as ‘thing knowledge’ – a belief that the things we make also portray our knowledge of the world. Similarly, de Vries (2005) sees the ‘knowing how’ type of knowledge as skills and practical knowledge, which are built up through experience over time. The students’ knowledge of chocolate and chocolate-making in this study was initially, and not surprisingly, reliant on their prior knowledge – their ‘funds of knowledge’ gained through their families, their communities and their pre-school experiences. In order to gain a picture of students’ procedural knowledge, which developed as a result of their experiences during the visit and the technology project, a carefully selected range of items was presented and became the focus of several interview questions.

The data collected before the visit indicated that the students’ knowledge of the process of product development was mostly very limited, with some beginning understandings of how family baking was achieved. The interview data collected six months after the visit showed that, as a result of their experiences during this time, there had been a period of incubation – best likened to the ‘simmer and brew’ analogy (White, 1954 cited in Yaden, 2003, p. 348) referred to in Chapter 7, during which the students’ understandings of technological process had gradually clarified and consolidated. In analysing the gains and losses achieved by the students over the six-month period, and including all the products the students discussed during the study, the findings indicate that most of the students (10 of the 12 students) had made noticeable gains in their ability to describe the steps of a technological process. They were more inclined to discuss the individual parts of a product than previously and, perhaps as a result, were more aware of the need to mix and combine ingredients. The greatest gains were noted in the comparison of the students’ descriptions of items other than chocolate-based products, most notably how the toddler’s jandal might be made. The literature suggests that this development resulted from increased knowledge of materials and their properties, further development of language competencies, resulting in greater proficiency in solving problems – in the case of this study, solving technological problems (Krause et al., 2010).

The changing state of matter was identified as a relevant and necessary concept within the process of making chocolates and this was included in the learning intentions of the technology unit. This aimed to increase students' understandings within the context of chocolate-making, and ultimately, within product development generally. There is clear evidence from the final interviews, that six months after the visit, the students understood that chocolate needed to be melted in order to mould it into shapes, and it needed to be hardened before it could be eaten. Whilst some of the language required to express these ideas had, as described in section 8.4.1.2, been lost along the way, the substituted language adequately conveyed their understandings of the changes that had taken place.

Another important concept that emerged during the unit was the students' perceptions of machinery and equipment and how these might be employed during the process of making chocolates. Some interesting changes in their understandings were recorded. Prior to the visit, simple household items were mentioned that could be used to make chocolates and when anticipating what they might see at Candyland, some students referred to generic 'machines', which would carry out a whole range of functions. Six months after the visit it was noted that the students were beginning to discuss equipment and appliances as an essential part of production and that were capable of specific functions. As previously, however, some of the terminology had been forgotten and was replaced with substituted words or approximations – predominantly those items that referred to processes used in the factory and which, at this point, had received less attention since the teaching unit had been completed.

8.4.5 Transfer of knowledge and understandings to new contexts.

A key concern of the EOTC Guidelines (2012) is that learning beyond the four walls of the classroom will "support the direction and contribute to the breadth of learning described by the national curriculum" (p. 3). Whilst this view does not directly influence the findings and analysis of this study, it does give additional purpose and guidance to the study for teachers working within the boundaries of the New Zealand curriculum. Furthermore, there is evidence that supports the view that students learn best when they can make connections to prior learning and experiences (Ministry of Education, 2012). The visit to Candyland and the students' experience of developing a gift for Mothers' Day were intended, to not only extend students' knowledge of the world around them, but also provide knowledge and skills from which to draw when faced with new challenges – specifically those associated with technology. Naturally, the extent to which an experience can be remembered and applied to new contexts is highly dependent on the quality of the experience as detailed in Section 8.2. This section considers the ability of the students to use the technological knowledge acquired during their visit and to apply it when describing how other products might be made.

In order to determine the impact of the visit on the students' ability to transfer their understandings of making chocolates to a range of other products, a comparison is made between the data gathered before the visit, and the two data sets gathered after the visit. From the outset the students' knowledge of chocolate-making was very limited and they mostly considered the use of ingredients and a small number of kitchen utensils. After the visit, as noted in Section 8.4.1.3, the students' had begun to use context-specific vocabulary, and it was noted that there was a greater focus on the sequence of construction as well as reference to the equipment and machinery that was required when making chocolates. Six months later, these ideas had been retained and consolidated with students confidently describing how a similar chocolate product might be made. Between the interviews recorded before and directly after the visit, there was an uncritical application of the chocolate-making process to the construction of a wooden product. Six months later, the students appeared to be more aware of material properties, and had developed a novice understanding of technological development and that this could vary within different domains.

Siegler and Alibali (2005) remind us that young students tend to store the gist of an event in their memory and sometimes fail to absorb important details. This is influenced by the 'lens' through which they view the world and what they notice as being important (Falk et al., 1998). Having the support of 'a more knowledgeable other' as described by Vygotsky (1978) is, therefore, critical in the development of students' new understandings and, most importantly, the filtering out of misconceptions which so easily develop when a student's language, logic and abstract thinking is still evolving. It would seem, therefore, that the ability of young students to successfully transfer knowledge from one context to another within this study depended on a number of elements being present. Firstly, their language development needed to allow them to engage with both the context and with the parent-helpers, and to think about, question and clarify their experiences. Secondly the experience needed to be well-structured, as summarised in Section 8.2.2, with the students' perceptions of what they had seen being interpreted, clarified and confirmed by one of the parent-helpers or their teacher. This ensured a shared understanding of the experience and the beginnings of a technological literacy, which helped them to interpret new experiences.

8.4.6 Summary

This chapter has considered the four research sub-questions that aim to determine how the merger of technology education and EOTC can be planned for five-year-olds, how a site visit can enhance student learning, and to establish the nature of the learning outcomes directly after a visit and six months later. Section 8.5 lists the resulting conclusions of this study, and section 8.6 presents the recommendations that have emerged from this investigation.

8.5 Conclusion

The findings and discussion of this study highlight a number of key points concerning teacher planning and implementation of a technology unit, which incorporates a learning experience outside the classroom for five-year-old students. In addition, a number of teaching strategies have been identified which complement these points, and which support the development of technological outcomes in a New Entrant classroom.

(i) Preparation

This study found that preparing the students for EOTC is multi-layered, and careful thought needs to be given to the issue students are to address, the selection of the EOTC site and their familiarity with the language of the context being studied. The selection of a suitable technological challenge provided a genuine purpose for the site visit and allowed the students to participate with enthusiasm and confidence. Selecting a need or opportunity that enabled students to complete the technological process by creating a final outcome for a specified consumer was a valuable experience and worked well for most students. Equally, the choice of a site that supported students in gaining an understanding of the technological practice associated with their product appeared to guide their technological practice that followed. The short length and keen focus of the visit allowed students and parent-helpers to maintain engagement in the learning task. The site also provided easy access to refreshment stops and bathroom facilities, both of which were considered to be important. Where students had acquired context-specific vocabulary and some knowledge of the practice of the chocolate makers prior to their visit, they were able to engage more readily with the elements of the visit.

(ii) Parent-helpers

It was clear in this study that five-year-old students needed prompts and support from the adults who accompanied them on the site visit, in order to connect their technological learning at the chocolate factory with their practice in the classroom. This support from the parent-helpers and the factory presenter was effective when they were fully aware of the goals of the students' practice, and the nature of the learning intentions that guided the study. When the parent-helpers were given very clear direction about the teaching points to be achieved during the visit including the vocabulary to use, items to draw students' attention to and reminders about the information-gathering purpose of their visit, they were able to provide effective learning support.

(iii) Review

Once a visit has been completed and students have returned to school, this study concludes that an immediate review of the learning experiences is critical and has the potential to create memories that are detailed, robust and enduring. This needs to occur within the 'time window' referred to by Rovee-Collier (1995) before students' memories begin to diminish. Where this was done well, it included tasks that consolidated student learning, established shared understandings of the visit and rectified any misconceptions that may have developed as a result of students' prior knowledge.

(iv) Understanding technological process

The five-year-old students participating in this study required significant scaffolding in order to appreciate the links between the phases of their technological practice, particularly the connection between their goal of making chocolates for Mothers' Day and the final outcome. The parent-helpers who were well-versed in the aims of the project, and the process the students had previously worked through, were more likely to support students in achieving the objectives of the project. The parent-helpers who were not provided with this information tended to deflect the students' attention away from this by introducing new directions.

(v) Transfer

An outcome of students' learning in technology in this study was to develop conceptual understandings that can be transferred to new contexts. This study concludes that the students made significant gains in their understanding of technological practice within the chocolate-making context and were able to transfer these understandings, sometimes uncritically, to other contexts. Their limited knowledge of materials and material properties, however, prevented them from anticipating some elements of product development where unfamiliar materials were required.

(vi) Language

The development of students' context-specific language was fundamental to their engagement in the context and their understanding of the practice of the chocolate-maker. In this study, the students benefitted from having specific vocabulary introduced early in the unit. When it was reinforced during the visit by the parent-helpers and revisited by the teachers during follow-up activities back in the classroom, language gains were evident in the students' interviews directly after the visit. It is believed that the focus on students' language development helped shape their memories of their experiences, and enhanced their recall of information several months later. It allowed them to retain robust conceptual understandings associated with the technological practice of the chocolate makers, despite some students' failure to recall correct terminology and resorting to substitutions and approximations when the language was no longer part of their everyday conversations.

Section 8.6 provides recommendations based on these conclusions, which offer support for teachers planning an experience outside the classroom in technology, as well as in other curriculum areas.

8.6 Recommendations

The extensive focus on literacy and numeracy in New Zealand schools over the last few years has impacted on learning areas such as Technology Education. This has resulted in the reduction of funding for in-service programmes and minimal professional development offered in both technology education and in support of the new EOTC Guidelines. Partially in response to this but largely as a result of the findings of this study, the following recommendations are presented to guide teachers who are planning to teach a technology unit that incorporates an EOTC experience.

(i) Professional development

Professional development that reflects the 2007 curriculum and its supporting documents is an essential requirement for all classroom teachers. In the context of this type of study, the teacher who is knowledgeable about the nature of the technology curriculum and familiar with the content of the EOTC Guidelines is best positioned to plan and carry out a technology unit (Jones, 2001), which incorporates a visit away from the classroom. Without a sound working knowledge of each of these documents, it is unlikely that the teacher will be able to facilitate students developing technological literacy or make crucial links between the EOTC experience and the technology curriculum.

The students' knowledge of technological practice and their developing technological literacy are central drivers of a technology unit and it is only through a sound knowledge of the technology curriculum that a teacher will be able to facilitate students' understanding of the connections between each phase of their practice, planning their next steps, and maintaining focus on their final goal or outcome.

ii) Teacher knowledge of EOTC and the characteristics of five-year-olds

When working with five-year-old students, teachers need to organise short, focused visits away from the classroom, that are age-appropriate and that provide opportunities for students to gather information, which will inform the selected aspect of their classroom programme. The site should address not only the educational needs of the students but also physical, social and emotional needs, which are particular to their age-group.

Student engagement with the EOTC experience will be strengthened if teacher planning includes the development of a bank of relevant context-specific vocabulary and some knowledge of the practice of the factory expert prior to their visit i.e. the materials, machinery, equipment and processes that are part of production. This will enable students to understand and participate more readily in the activities that are provided.

iii) The role of parent-helpers

The support of well-prepared and well-informed parent-helpers, working with small groups of students, is a critical element of an EOTC experience particularly when working with five-year-old students. Along with a supervisory role, parent-helpers can offer effective learning support, which will enhance the learning opportunities of the students. It is unlikely that this can be achieved as effectively if it is the sole responsibility of the classroom teacher.

During the final stages of the technology unit when students are creating their chosen outcome, the support of parent-helpers who understand the purpose of the technology unit and are fully informed about the preparation and the phases students have carried out prior to 'the making day' will have a significant impact on drawing these final threads of the technology unit together. Without this knowledge, parent-helpers can inadvertently divert students' interest and attention away from their original plans and bring about an outcome that does not reflect the research and design they have previously carried out.

(iv) *Student review and reflection*

A review of the EOTC learning experiences directly after the visit is recommended as this not only consolidates student learning, but has the potential to create detailed and enduring memories of the experience, which can be used to inform technological challenges arising in other contexts. This review can be achieved through students' drawings, discussions, story writing and, importantly, the review of photographs or videos recorded during the visit. Context-specific language can be reinforced and students' attention can be redirected to the information they 'need to know' in order to move forward in their practice.

8.7 Final comments

The story that has unfolded through these chapters, beginning with the tale of James and his first school excursion, through to the recommendations of this chapter, has been a long and constant journey. My work life has undergone minor changes, but continued with little disruption. The family has grown in size with new babies born and the level of activity within each family group escalating at a rapid rate. Houses have been bought and sold. We have celebrated marriages and mourned the passing of some of the old ones. All the while, the story of the students' visit to the chocolate factory and how they made a chocolate gift for Mothers' Day has continued steadily onwards.

The literature review of this study and the earlier experience in 2004 of observing and analysing the practice of four teachers as they embarked on an EOTC experience, provided a valuable platform from which to develop the intervention model for this project. The data gathered during the students' technology unit and their visit to Candyland showed clearly that the provision of EOTC within technology education is an effective strategy for sharing the knowledge of experts with very young students, and the time and commitment of resources to EOTC is wholly justified. However, the example provided in this study demonstrates that technology education presents a useful vehicle with which to integrate not only EOTC but many other core curriculum subjects. It provides the opportunity to link the achievement objectives of the curriculum to real-world activities and offers a genuine purpose for the teaching and learning goals of the classroom. Together, this offers a number of interesting future research opportunities where I see core subjects such as technology, science, social studies or the arts becoming vehicles for teaching literacy and numeracy, rather than attempting to find a place for them within generic contexts, which advantages some curriculum areas over others and generally lack opportunities for students to engage in the real issues of their community. An exciting prospect! My final comment comes from Hannah, one of my research teachers, who was able to reflect so wisely on the experiences of her students and the benefits inherent in teaching technology education to the junior students in our primary schools. She stated:

> Technology education is to give the kids a sense that there are all these things that happen out in the world and the knowledge that ‘I can actually do some of it, I have some power, I have some expertise’ - just because you’re a little kid you’re not just a bystander, you can actually play an active role and plan and decide, and make decisions (Hannah, second teacher interview).

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Appendices

Appendix A

1. Information and consent letter to principals
2. Consent form for parents
3. Consent form for provider (Candyland)
4. Student interview questions before the visit
5. Student interview questions after the visit
6. Student interview six months after the visit
7. Teacher interview questions after the visit

Appendix A

1. Information and consent request to principals

The Principal

Oldpark Country Model School

RD 6

HAMILTON

28 February 2008

Dear Principal,

This is a follow-up information letter to my discussion with you seeking your school's participation in my research. The research is being carried out in order to collect data for my PhD (University of Waikato). I have elected to undertake a project which will enable me to examine Education Officers', teachers' and students' perceptions and experiences related to learning experiences outside the classroom when working with New Entrant students. The bulk of this work will be centered on a visit possibly to Donovan's Chocolates though this is yet to be confirmed. The curriculum area in which I am particularly interested in is Technology Education. This work will mostly focus on the requirements of the 2007 curriculum level 1 with some attention to being given to the Te Whaariki curriculum. I would like to undertake this phase of data collection late in term one or early in Term two, 2008.

If you agree to become a participating school, I will require access to a New Entrant class and permission from the teacher to observe and interview before, during and after their visit. I will also need to organise follow-up visits six months and one year after the visit in order to gather longitudinal data. After the site visit I would like to observe a classroom lesson connected to the visit and possibly collect copies of relevant work samples and teacher documentation, such as planning sheets.

If you are happy to give your approval for this work to be carried out, I will gain the informed consent of the participating teacher along with the care-givers of students in the New Entrant class before any research is undertaken.

You can be assured that your school's involvement will remain anonymous, as will the identity of the teacher and her students. Confidentiality will be maintained in any reporting and presentation of findings. In addition, participants' permission will be sought for the use of any photographs which I may require as part of future research publications and/or presentations.

If approval is given would you please complete the attached form and return in the envelope provided. If you require further details or have any questions please contact me at: email: louisem@waikato.ac.nz or ph: 07 838 4680.

Any problems which arise during the research that I am unable to resolve, please feel free to contact my supervisor Dr Chris Eames, Centre for Science and Technology Education Research: email: c.eames@waikato.ac.nz or ph: 07 838 4357.

Yours faithfully,

Louise Milne

Lecturer Technology Education

School of Education

The University of Waikato

Private Bag 3105

Hamilton, New Zealand

Ph 838 4680: Mobile 0274 410 939

Learning Experiences Outside the Classroom

Principal's consent

I give permission for (teacher's name) and her students to be involved in a PhD research project being carried out by Louise Milne, University of Waikato

Signed: ____________________________________

Date: ______________________________________

Principal's contact details:

Tel: 07 856 5946

Email:

Please return to:

Louise Milne

School of Education

University of Waikato

PB 1308

Hamilton

2. Consent form for parents

14 April 2008 and university details and logo

Dear Care-giver,

This is an information letter which seeks to gain permission for your child to participate in my research. Your child's Principal and teacher have previously consented to being involved.

The research is being carried out as part of my PhD and will study children's learning experiences outside the classroom. This work will be based on a visit to 'Candyland' and I hope to examine their ideas and experiences related to this visit. I am planning to undertake this work at the beginning of Term 2, 2008 directly after the holidays.

I would like to include your child in this and if you agree, he/she may be involved in the following way:

- Interviewed before and after the visit for around 15 minutes.
- Chat informally with me at 'Candyland'. Interviews may be audio-taped and you may request a transcript at any time.
- Observed in the classroom before, during and after the visit: I will be taking field notes to help document this.
- Photographed during these occasions: No photograph in which your child could be identified will be used in my thesis, publications or presentations of this work.
- Provide copies of his/her schoolwork related to the visit: I will take steps to ensure that any time I spend with your child will not affect their learning opportunities.
-

I will also take time to explain the work to your child before I interview, observe, or take copies of his/her work. He/she can withdraw from the research at any time and you may also withdraw your child at any stage. If there is withdrawal I will return any work that has been gathered. I will not use your child's name or the name of the school in any publications or presentations, so his/her work and ideas remain anonymous.

In addition I will organise a follow-up visit six months and one year after the visit and may interview your child again at these times. As he/she will most likely be in a different class by then, I will seek your permission and that of your child's teacher nearer the time.

If your approval is given would you please complete the attached form and return to the classroom teacher. If you require further details or have any questions please contact me at:

email: louisem@waikato.ac.nz or ph: 07 838 4680.

Any problems during the research that I am unable to resolve, please feel free to contact my supervisor Dr Chris Eames, Centre for Science and Technology Education Research: email: c.eames@waikato.ac.nz or ph: 07 838 4357.

Yours faithfully,

Louise Milne

School of Education

The University of Waikato

Private Bag 3105

Hamilton, New Zealand Ph 838 4680: Mobile 0274 410 939

3. Consent form for provider (Candyland)

Date and university details/logo

Dear ____________________,

This is a follow-up information letter to my telephone call to you seeking your involvement in my research. The research is being carried out in order to collect data for my PhD (University of Waikato). I have elected to undertake a project which will enable me to examine provider's, teachers' and students' perceptions and experiences related to learning experiences outside the classroom when working with New Entrant students. This will be based on a visit to (the site name) by a New Entrant class and I intend undertaking this phase of data collection during Term one, 2008.

If you agree to become a participating site, your involvement will entail an interview about the work you are doing with schools and your expectations of the students' visit, prior to the visit. After the students' visit I would also like to carry out a follow-up interview to ascertain how you think the site visit went. With your permission I would like to photograph aspects of the site, audiotape the interviews and later on provide you with the interview transcript for verification.

I would appreciate the opportunity to work in (name of the site) and I seek permission from yourself and any other authority necessary to conduct my research there. You can be assured that your personal involvement will remain anonymous, (name of the site) will not be identified and confidentiality will be maintained in any reporting and presentation of the findings. In addition, your permission will be sought to use any photographs which I may require as part of future research publications or presentations.

If this approval is given, would you please complete the attached form and return in the envelope proved. If you need further details or have any questions please contact me at:

email: louisem@waikato.ac.nz or ph: 07 838 4680)

If you have any problems during the research that I am unable to resolve, please contact my supervisor Dr Chris Eames, Centre for Science and Technology Education Research: email: c.eames@waikato.ac.nz or ph: 07 838 4357.

Yours faithfully,

Louise Milne

School of Education

The University of Waikato

Private Bag 3105

Hamilton, New Zealand

Ph 838 4680: Mobile 0274 410 939

3. Students' interview questions before the visit

1. Why are we going on the trip to Candyland?
2. How are you feeling about the visit?
3. Have you been to Candyland before?
4. What do you think you might see?
5. Do you think you will learn anything new during the trip?
6. Do you have anything special that you need to find out about during the visit?
7. How is this going to help you make your (product)?

   Introduce first item – the academic bear

8. How do you think a person who makes toys would make this little bear?
9. What do you already know about this little chocolate fish. How you think it was made?

4. Students' interview questions after the visit

1. Last week we went on a trip out to Candyland. Can you tell me why we went there?
2. How did you feel about the visit?
   a. Was there anything about the trip that you wouldn't like to do again?
   b. Was there anything about the trip that you would like to do again?
   c. What was the best part of the trip?
   d. What was the worst part of the trip?
3. What did you see during your visit to Candyland?
4. Did you learn anything new during the trip?
   a. If so, what did you learn?
5. Did you have anything special that you needed to find out about during the visit?
   a. If so what was it?
   b. Did you find the answers?
   c. What were the answers?
6. Were Lance and John helpful? How?
7. Did you understand what they were saying to you?
8. Tell me all the things that Lance and John did when they helped you to make the little chocolate fish? (Use children's drawings as a prompt if necessary)
9. Did this help you make your chocolate gift for Mum?
   a. How did it help you?
10. Did the parents help you in any way?
11. Tell me the things you had to think about in order to make Mum's chocolate gift.
12. Tell me all the things you needed to do in order to make Mum's chocolate gift?
13. Ms Mather asked you to make a model of your chocolate for Mum. Why do you think she asked you to do this?

14. How did you know what chocolates Mum liked?
15. Did you make your chocolate the same as what Mum said she liked?
    a. Why or why not? *(Prompt to parent helpers if necessary)*
16. Were you happy with the chocolates you made?
17. Was Mum happy?

Introduce second item, the Tiny Teddie biscuit

18. Thinking about what you saw at *Candyland* and how Lance and John helped you make the chocolate fish, how do you think this chocolate bear might have been made? *(Show a Tiny Teddie biscuit – let children handle and break it open [and eat afterwards])*
19. Thinking about what you saw at *Candyland* and how Lance and John helped you make the chocolate fish, how do you think a person who makes toys would make this little toy?
20. Why do you think people make all the things around us?
21. What do you think 'technology' means? *(Prompt with a picture of a range of household and work related items)*

3. Student interview six months after the visit

1. Earlier this year we went on a trip out to Candyland. Can you tell me why we went there?
2. How did you feel about the visit?
    a. Was there anything about the trip that you wouldn't like to do again?
    b. Was there anything about the trip that you would like to do again?
    c. What was the best part of the trip?
    d. What was the worst part of the trip?
3. What did you see during your visit to Candyland?
4. Did you have anything special that you needed to find out about during the visit?
    a. If so what was it?
    b. Did you find the answers?
5. Tell me all the things that Lance and John did when they helped you to make the little chocolate fish? (Use children's drawings as a prompt if necessary)
6. Did this help you make your chocolate gift for Mum?
    a. How did it help you?
7. How did you know what chocolates Mum liked?
8. Ms Mather asked you to make a model of your chocolate for Mum. Why do you think she asked you to do this?
9. Tell me all the things you needed to do in order to make Mum's chocolate gift?
10. Did you make your chocolate the same as what Mum said she liked?
    a. Why or why not? (Prompt to parent helpers if necessary)
11. Were you happy with the chocolates you made?
12. Was Mum happy?

Introduce the third item – the toddler’s jandals

13. Thinking about what you saw at Candyland and how Lance and John helped you make the chocolate fish, how do you think this chocolate Father Christmas might have been made? (Show a marshmallow Father Christmas – let children handle and break it open [and eat afterwards])
14. Thinking about what you saw at Candyland and how Lance and John helped you make the chocolate fish, how do you think a person who makes shoes would make this little jandal?
15. Why do you think people make all the things around us? (Show a pen, watch, tape recorder, glasses and book – things on the table.)
16. What do you think ‘technology’ means? (Prompt with a picture of a range of household and work related items)

5. **Teachers’ interview questions after the visit (**Questions focus on expectations of the visit)

1. Have you taken students on a trip previously which was part of a technology unit?
2. Why/why not?
3. How were you feeling about the visit last week prior to going?
4. Did you have any expectations/concerns?
5. How would you rate Candyland as a site for taking New Entrant students to?
6. What were your impressions of the staff?
7. Do you feel that you were well prepared in terms of –
    a. your planning?
    b. the students preparation?
    c. the parent-helpers’ role?
    d. knowledge of the site?
8. Is there anything that you would change in terms of this preparation if you went again on the same visit e.g. as listed above?
9. How did you see your role during the visit in terms of maximizing children’s learning?
10. If you were describing to a first year teacher how to go about planning a successful trip what would be some of the key features of this?
11. What did you anticipate would be the main value in going on this visit? (Prompt re L.I’s intentions)
12. Do you think this was achieved?
13. How do you know?
14. What would be two things which you hope the students will gain from this visit?
15. What sorts of things would you normally do to ensure that the learning is memorable?
16. Anything else you would like to add?

Appendix B

1. Parent-helper information

2. Teaching unit

3. Students' taste-testing analysis form and consumer research form

4. PNI template

5. Coding example

1. Parent-helper information

17 March 2008

Dear Parents and Care-givers,

Re parent help for visit to factory

Earlier this month you will have received a letter requesting permission for your child to participate in a research project. This project is being carried out in order to collect data for my PhD (University of Waikato) with the main focus being to identify the key features of successful EOTC (Education outside the classroom). In other words, investigating how can we manage a visit outside the classroom so that it is interesting, memorable and with good learning opportunities which the children will remember.

Thank you very much for agreeing to assist us with this visit and as part of this, I hope you may be prepared to meet briefly with me just before we leave so that I can explain what your role will be and a little of the background in terms of the children's learning goals. The cars will leave at approximately 9.30 a.m. for *Candyland* and I would like to meet with all the helpers in the classroom at 9.05 a.m.

For your information, I have summarised some points below relating to this type of experience, and which we can discuss further at our meeting.

Many thanks for your help,

Louise Milne

2. Parent-helper prompt sheet

SUGGESTIONS FOR WORKING WITH THE CHILDREN DURING OUR CANDYLAND VISIT

Dear Parents,

Thank you very much for your assistance today. You have a special role to play today and here are some suggestions of things you can do which will help the children's learning during our visit to Candyland.

1. **Know the learning goals of the visit**
   In this visit these are as follows:

   Children will-

   a. Understand that chocolate, as a solid material used in making sweets can be heated, melted and used to construct different shapes
   b. Understand that chocolates and sweets which are made for people to eat must be hygienically prepared and packaged so they are safe to eat
   c. Understand that making a chocolate gift requires a series of sequential steps including having a recipe to follow, finding the correct ingredients, heating, mixing, adding flavourings and/or colourings, shaping, cooling and packaging.

d. Understand that there are <u>many different types of chocolates</u> including white, milk and dark chocolate, chocolate with fillings, coloured chocolate, shaped chocolate, bars of chocolate, hollow chocolate shapes and so on.
e. Developing and using the language associated with chocolate making as referred to above e.g. melt, flavour, colour, mix, cool and so on.

2. **Talk to the children about these learning goals** as you go through the factory making sure they know why they are there.
3. **Interpret the presentations and products** the children are seeing if you think they may not understand
4. **Keep presenting the correct language** to the children e.g. the shapes, the colours, the moulds, the fillings, the colourings – whatever you think is appropriate and relevant

<u>During the shop visit</u>

After the chocolate and lollipop presentations take your group through the shop as

this is an important part of their design work next week – they need lots of good ideas. Make sure they see the following:

- All the different types of chocolate (as mentioned above)
- All the different moulds (talk to them about which ones they think Mum might like and make a mental note for me later)
- Look at the fillings you can put in chocolate (again get them to think about which ones Mum might like)
- Look at the containers of colouring (do they think Mum would like coloured chocolate or the 'normal' chocolate)

Many thanks for your help,

Louise Milne

2. Teaching unit

T e c h n o l o g y   U n i t   P l a n   F o r m a t

Context: Making chocolates for a special person	**Level:** One
Time frame: Two weeks	

Issue: Mothers' Day is coming up and the students would like to make a gift for their mother or caregiver. After a brainstorm they agree to make chocolates. Their challenge is to make chocolates which their mother/caregiver particularly like and which will be safe for her to eat.

Attributes to guide student practice: (Negotiate further with children)

- The chocolates must be safe to eat i.e. they must be hygienically prepared
- The taste and filling must be appealing to the receiver
- The chocolates must be packaged appropriately e.g. in sealed plastic bags
- The chocolates must look attractive e.g. clear shape, solid, good colour (dark, milk, white …)

Achievement Objectives Level One

<u>**Technological practice**</u>	<u>**Technological knowledge**</u>	<u>**Nature of technology**</u>
Planning for practice ○ Outline a general plan to support the development of an outcome, identifying appropriate steps and resources **Brief development** ○ Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available **Outcome development and evaluation** ○ Investigate a context to communicate potential outcomes. Evaluate these against the attributes; select and develop an outcome in keeping with the identified attributes	**Technological modelling** ○ Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes **Technological products** ○ Understand that technological products are made from materials that have performance properties **Technological systems** ○ Understand that technological systems have inputs, controlled transformations, and outputs	**Characteristics of technology** ○ Understand that technology is purposeful intervention through design **Characteristics of technological outcomes** ○ Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature

Learning Intentions New Entrants

<u>**Technological practice**</u>	<u>**Technological knowledge**</u>	<u>**Nature of technology**</u>
Planning for practice *Students will:* • develop, with the teacher, a plan of the steps they will follow in order to design and develop chocolates for an identified person e.g. their mother, caregiver or other special person • identify, with the help of the teacher, the materials and equipment they will need, and can reasonably obtain, in order to construct their chocolates **Brief development** Students will be able to: • identify the preferences of their 'special	**Technological modeling** *Students will:* • understand that by developing models and/or design drawings, students can test their design ideas and communicate their requirements for equipment and ingredients to their teacher **Technological products** • understand that chocolate, as a solid material used in constructing sweets can be heated, melted and used to	**Characteristics of technological outcomes** *Students will:* • understand that technology is about ":having ideas and making them" (Know How 2, 1998) **Characteristics of technological outcomes** • understand that all the things we use in our daily lives have been made by people to help us in some way.

person' when choosing chocolates to eat • develop models or simple drawings of their chocolates in order to describe the attributes they will have, e.g. white chocolate, walnut centre, square shaped, small sized • develop models which meet the needs of their chosen recipient e.g. match the recipients preferences **Outcome development and evaluation** • develop chocolate gifts which meet the needs of their chosen recipient e.g. hygienically prepared and packaged, and match the recipients preferences	construct different shapes **Technological systems** • understand that making a chocolate gift, as a technological system, involves a series of sequential steps including the supply of ingredients, specific processes and preparation in order to achieve a successful product.	
Key learning intentions for assessment *Students will be able to:*	**Success criteria** *Students will be able to:*	**Method of data collection** *Students will develop :*
KLO No 1: identify the preferences of their 'special person' ...	KLO No 1: clearly articulate the preferences of their chosen person from a provided pictorial interview sheet	KLO No 1: a pictorial interview sheet which students will highlight and describe to the teacher/researcher
KLO No 2: explain the technological system involved in chocolate making …	KLO No 2: identify three or more stages in the production process of creating chocolate confectionary	KLO No 2: a simple flow chart showing three of more pictures of the chocolate making process which they will describe to the teacher/researcher
KLO No 3: develop models or simple drawings of their chocolates in order to describe the attributes they will have	KLO No 3: construct and describe a model or drawing of their proposed chocolate gift which clearly illustrates their design ideas	KLO No 3: a play-dough model/simple drawing of their chosen chocolate which they will describe to the teacher or researcher

Integrated curricula – Science

Achievement Objectives, Level One Material World - Properties and changes of matter

- Observe, describe, and compare physical and chemical properties of common materials and changes that occur when materials are mixed, heated, or cooled.

The 'big technological ideas'

Fitness-for-purpose: A chocolate gift will be successfully achieved if the student understand the needs and preferences of the consumer, he/she follows a sequential series of steps in its preparation, and the product is prepared in accordance with accepted hygienic practices of food preparation as listed in the MOE *Safety and Technology Education: A guidance manual for New Zealand schools.* (See below)

Safety considerations (see MOE *Safety and Technology Education: A guidance manual for New Zealand schools*)

Refer to section 1, 2 and 5 – Safety and food technology

Equipment/Resources

Chocolate making utensils including moulds

Pre-teaching and planning	
<u>Teaching sequence</u> 1. Teacher/students clearly establish scenario for the unit e.g. Mothers' Day coming up/just been/chocolates often given as a gift. Maybe chart this to refer back to at the beginning of each session so students remember where they are heading as they work through the unit.	**<u>Student tasks</u>**
2. Establish problem to drive unit e.g. making chocolates for Mum. 3. Discuss <u>how</u> we could find out how to make chocolates and link with the need for a visit to find an expert to show us. Maybe talk about what the chocolates would need to be like e.g. *that are safe to eat and that are (Mum's) favourite".* 4. Establish <u>what</u> students need to know/find out in order to solve problem.	
5. Talk to them about the importance of having a plan when you want to make something e.g. when a builder builds a house, or a toymaker makes a new toy. Together write up as a series of steps to follow e.g. decide what to make, find someone to help us, go and visit the helper, find the ingredients etc This should lead neatly into need to find an expert or visit an expert e.g. 'Candyland'. <u>Chart ideas and name each child's contribution</u>.	
6. **Brainstorm** what students know about the different types of chocolate, e.g. dark chocolate, milk chocolate, coloured chocolate, shapes and fillings. <u>Chart</u> these for reference later. (Could do a simple taste testing exercise here. See item No 20.)	(Taste testing possibility instead of later.)
7. Find out children's **existing knowledge** about how chocolate is made. Maybe draw a small sequence of pictures showing how they think this would be done.	Students draw sequence of pictures
8. **Teach/discuss** the chocolate making process from the fruit of the cacao tree to the production of large blocks of sweetened chocolate for further use at e.g. Candyland where they don't make their own chocolate but buy in bulk blocks.	
Preparing for the visit	
9. Think about what they would like to make and how they might do that. Children draw a 'first ideas' picture of what they might make. (This should lead into deciding what questions they will need to ask at Candyland).	Children draw a 'first ideas' picture of what they might make.
10. Explain the programme for the visit to students e.g. the chocolate making presentation, the lollipop making presentation, and the investigation in the shop of the different types, shapes and colours of chocolates.	
11. Children organised into small groups of three or four with one parent helper to supervise.	
During the visit	
12. Children and parent helpers assemble outside Candyland for morning tea. [6]Children move through factory visit with parent helper. Parents interpret activities if and when necessary and also emphasis key points if they consider the children may have missed them. Also endeavour to keep children focused and on-task – e.g. finding out how to make a chocolate gift for (Mum). 13. Prompt children to ask their prepared questions and any others they might think of. (Parents help with this).	
14. After the show, parent helpers take children around the shop to look at all the different types of chocolates e.g. the different colours, the fillings, the shapes and the 'cheeky' ones e.g. sheep poo and rabbits poo! Use the correct terms and encourage them to look at labels. Talk about how some of these products might have been made e.g. adding colouring or flavouring as they saw in the lollipop demonstration.	

[6] I thought it would be a good idea to have a <u>large</u> morning tea out at Candyland before they go into the presentation – fill up their little bellies! There is an area out to one side of the site where they could sit and eat and also have a run around if needed (as long as it isn't wet – that will need Plan B which I don't have at the moment – any thoughts??).

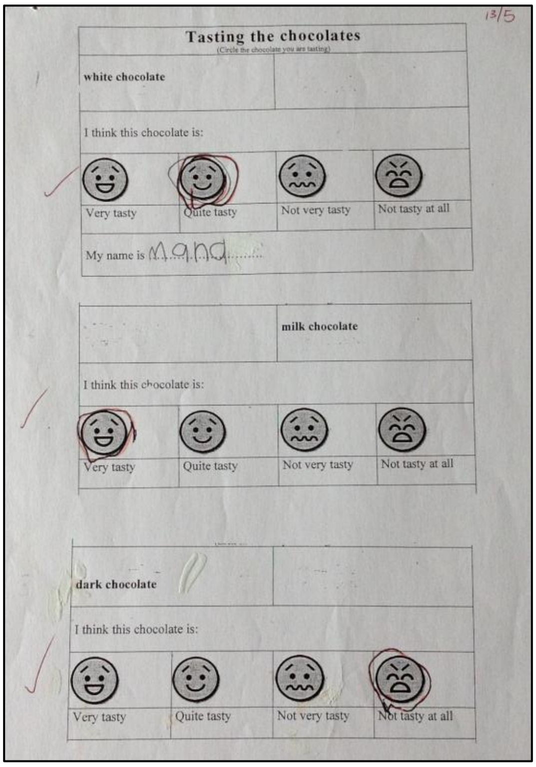
15. Take time to also look at the moulds available in the shop. (This is important as the children will need to link into these when they design their own chocolate gift). **Tell the parent helper which moulds they think (Mum) might like for her chocolate gift	.
After the visit	
16. After the visit show and talk about the chocolate making process/lollipop making process the children observed at the Candyland using a sequence of photographs to support their ideas. Ensure the language of the experience is used e.g. the ingredients, the processes, the machines, the stages of production e.g. syrup, moulds etc. Spend some time re-sequencing the activities so they understand that a specific process is important otherwise the chocolate making wouldn't be successful.	Sequence photographs of the chocolate making process at Candyland.
17. Students draw a picture showing what they learnt about the chocolate making process. Encourage them to talk about their drawings and if they can, draw simple labels showing the names of the equipment and ingredients. 18. Discuss/teach hygienic practices and the reasons for this. Link to the visit mentioning the hand washing, use of gloves and other special clothing. Maybe share stories of food poisoning?	
19. **B**rainstorm all the possibilities for the look (and filling) they have for their chocolates. Do this on separate charts or in separate sessions.	
Designing and making	
20. Discuss how the children will find out what (Mum) likes best when choosing chocolates and how they could remember her ideas so they can design their chocolate gift. Introduce the simple questionnaire for them to fill in for homework.	
21. Brainstorm/teach students about the different fillings that you can put inside chocolates. Carry out simple taste testing with a range of chocolates and a range of fillings as background knowledge for them – remembering who they are actually making the chocolates for. See feedback sheet	
22. In small groups, discuss/'analyse' the data they collected and then talk about the purpose of making a simple design drawing/ model of their chocolate gift i.e. (i) to help them decide what their chocolate gift might look like and (ii) to show you what they want to make so you can get the equipment and ingredients ready for them. [7]	
23. Using play-dough experiment with shapes and the size and patterns which they think would be appropriate for (Mum's) chocolates.	
24. Negotiate groups for children to make their chocolates e.g. those who have decided to make square chocolates or those who want to make stars etc.	
25. Develop a procedural chart as a class to show how the students will make their own chocolates. Discuss the use of moulds and a safe way they could fill them with the warm chocolate. (Technique at Candyland may help here).	
26. **Discuss how children might add in extras e.g. a simple filling or topping (piece of flake or swirl etc).	
Making the chocolate gift	
27. Teacher prepares equipment/space for the chocolate making. In small pre arranged groups, children prepare to make their chocolate gift (hygienic practices …) check/discuss their designs and then pour their moulds and add extras (whatever you are brave enough to include). Try to keep the children as involved as possible in discussions and make sufficient chocolates for them to taste test themselves, show the class and still leaving some for Mum! [8]	

[7] The idea here is to show them that there is a reason for this activity and it is different from a usual drawing or model – it describes rather than merely depicting. Children then draw a picture showing the chocolate they think (Mum) will really enjoy. (This is to check they understand the task)

[8] If the children don't keep to their plans when making their chocolates, it is not critical as long as they can say why they have made a change and I can gather that information.

28. In groups, children taste test their finished products and draw their chosen ‘smiley’ face on a chart. Writers can add a written comment. Encourage them to think about their ‘data’ regarding Mum’s preferences and whether they think they achieved it. If they think they didn’t achieve it, what might need to do another time – a simple reflection of the intended outcome and an opportunity to problem solve outcomes which we not as they intended.	
29. Package chocolates in a simple cellophane bag or similar to take home for (Mum). (Could also purchase simple containers from the Two dollar shop)	
30. Follow-up discussions	

2. Students’ taste-testing analysis form and consumer research form


13/5

Tasting the chocolates
(Circle the chocolate you are tasting)

white chocolate	

I think this chocolate is:

Very tasty	Quite tasty	Not very tasty	Not tasty at all

My name is Mana

	milk chocolate

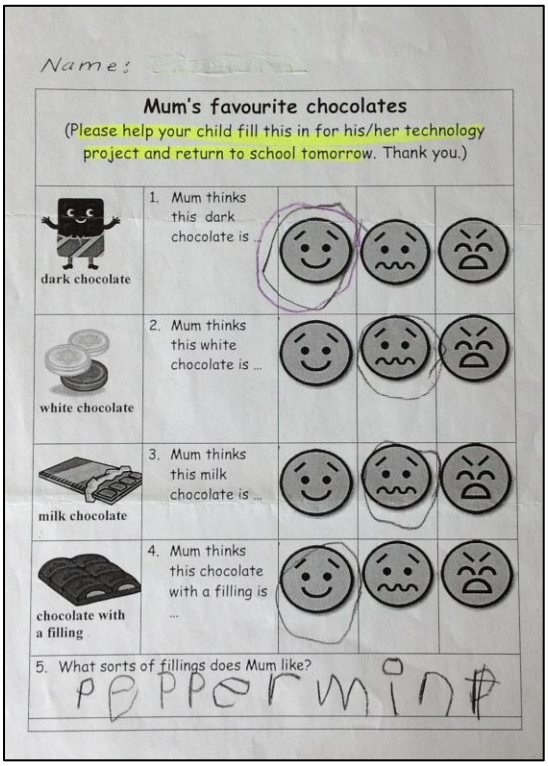
I think this chocolate is:

Very tasty	Quite tasty	Not very tasty	Not tasty at all

dark chocolate	

I think this chocolate is:

Very tasty	Quite tasty	Not very tasty	Not tasty at all


Name:

Mum's favourite chocolates
(Please help your child fill this in for his/her technology project and return to school tomorrow. Thank you.)

dark chocolate	1. Mum thinks this dark chocolate is ...			
white chocolate	2. Mum thinks this white chocolate is ...			
milk chocolate	3. Mum thinks this milk chocolate is ...			
chocolate with a filling	4. Mum thinks this chocolate with a filling is ...			

5. What sorts of fillings does Mum like?
pePPermint

3. PNI template completed during the second planning meeting between the researcher and the teachers

Positive, negative and interesting [P.N.I.]		
Considerations when planning a visit outside the classroom for five-year-old students		
Positive	**Negative**	**Interesting**
• Hands-on / kinesthetic experiences • Relevant to the teaching experiences/goals • Relevant to the students • Dynamic • Within a meaningful context • Of interest to the teacher • Offers new experiences • (new doors opened for the students) • Independent work opportunities (of special interest to NE students who have moved from Pre-school to school) • Challenging • Exhibits clearly visible • Include an element of making • New language introduced prior to visit – children prepared • Appropriate child/adult ratio achieved	• Too difficult in terms of both context and the manner in which it is presented • Unclear rules or boundaries for behaviour in the site • Distracted parents	• Prepare parents so that they understand their role during the visit • Have clear expectations • Prepare paper work in advance to address school and site safety obligations **Other** • Appropriate physical environment • Physical limitations of young students during outings

4. Coding example

Codebook 1: Area, themes and subthemes			
Level			**Theme**
1	**2**	**3**	EOTC (Education outside the classroom)
2.00			Sub-themes
	2.1		• **Understanding the purpose of the experience**
		2.1.1 2.1.2 2.1.6 2.1.3 2.1.4	• Able to accurately explain the purpose of the visit • Able to explain a purpose for the visit other than finding out about how to make chocolate • Unaware of the purpose of the visit • Able to link it to his or her own technological practice. • Not able to link to own technological practice
	2.2		• **Positive attitude towards the experience**
		2.2.1 2.2.1 2.2.2 2.2.3	• Able to anticipate the factory visit in a positive manner • Able to provide a reason for their positive response • Able to engage in the factory visit in a positive manner?? • Able to reflect on the factory visit in a positive manner
	2.3		• **Being prepared for the experience**
		2.3.1 2.3.2	• Offers ideas for preparing for the visit • Can identify questions to ask the presenters which will help solve the problem of how to make a chocolate gift
	2.4		• **Expectation of the factory visit**

		2.4.1 2.4.1a 2.4.1b 2.4.2	• Able to anticipate what might be seen during the factory visit • Aware of the role of staff (people) at the factory • Aware that other visitors may be present • Able to anticipate what they might do during the factory visit
	2.5		• **Expectations for potential learning**
		2.5.1 2.5.2	• Able to anticipate the learning opportunities associated with chocolate making which would be offered during the visit • Able to offer other suggestions for potential learning opportunities
		2.5.4	• Learning only occurs at Kindergarten or school
	2.6		**(f) Frequency of visit**
		2.6.1 2.6.2	• Has been to Candyland once before • Has been to Candyland more than once