The Language in the Trades Education Project

Jean Parkinson, Averil Coxhead, Murielle Demecheleer, James Mackay, Len Matautia, Emma McLaughlin, Falakiko Tu'amoheloa.

AKO AOTEAROA NATIONAL CENTRE FOR TERTIARY TEACHING EXCELLENCE

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The authors

Jean Parkinson teaches Applied Linguistics and TESOL at Victoria University of Wellington, New Zealand. Her research interests are genre and academic writing, particularly of scientific and technical genres.

Averil Coxhead is a Senior Lecturer in the School of Linguistics and Applied Language Studies, Victoria University of Wellington. Her research interests include vocabulary for specific and academic purposes in school, the trades, and university education; vocabulary size estimates for native and non-native speakers; and the vocabulary load of texts.

Murielle Demecheleer is a researcher on the Language in Trades Education project in the School of Linguistics and Applied Language Studies at Victoria University of Wellington, where she has focused on corpus development and text analysis. She has published in the area of vocabulary acquisition and metaphor.

James Mackay teaches in the School of Engineering at Wellington Institute of Technology. His research interests concern science and gender, student misconceptions in physics, and multiple representations of meaning in science and technology writing.

Len Matautia is a qualified carpentry tutor and professional carpenter at the Wellington Institute of Technology. Bringing together his pedagogical knowledge and knowledge of Pacific island society, Len has been responsible for the design and implementation of a unique approach to teaching and learning in the trades. He has made a number of presentations at national conferences including the annual National Centre for Literacy and Numeracy for Adults Symposium.

Emma McLaughlin is an Academic Advisor at Wellington Institute of Technology. She has a background in Applied Linguistics, Adult Literacy Development and teaching and training. Prior to her current role, she worked with the Police advising on language and literacy. She is particularly interested in understanding different discourses and how people acquire them.

Falakiko Tu'amoheloa has taught for over 20 years in secondary education in Tonga, specialising in Geography, Tongan Studies, Music and ESOL. He is currently completing his BA in TESOL and Education at Victoria University. He was a summer scholar at Victoria University in 2016/2017 as part of the Language in Trades Education project.

Executive Summary

1. Rationale

It is sometimes assumed that the trades are a good option for those who would prefer not to do much reading and writing (Leach & Zepke, 2010; Lehman, 2005). That this assumption is widespread is reflected in a British study by Cooper and Baynham (2005), which reports that many construction students were recommended to take up a trade because of their limited success at school. Yet previous research (e.g. Ivanič et al., 2009) suggests that the reading and writing that trades students engage in is complex (Smith et al., 2008) and diverse (Edwards, Minty & Miller, 2013). Our own research, undertaken at the Wellington Institute of Technology in New Zealand, supports this finding of complexity in the texts that students read in the four trades in our study: automotive technology, carpentry, fabrication and plumbing.

Indeed, the assumption that trades study does not involve complex literacy is founded on popular belief rather than on research. This reliance on popular belief may be partly because trades language and literacy has been neglected in the research literature. There are a large number of journals and textbooks investigating the language and literacy needs of university students who are acquiring the language and literacy of their disciplines. Such journals and textbooks assist the efforts of staff charged with supporting university students in acquiring disciplinary language. Yet there are no journals that focus on language and literacy acquisition in the trades. In fact, we have found no research that provides a description of the language of the four trades that we studied. Thus the description that we provide in this report fills a gap in the literature which is necessary if the trades-specific language needs of students are to be addressed.

The research outlined in this report shows that the texts read by the trades students in our study are lexically as demanding as university-level academic texts. Our report shows too that trades texts contain high levels of technical vocabulary, and that meaning in trades texts is expressed visually as well as in writing, using a wide range of drawings, graphs, photographs, etc. The report also shows the methods that trades tutors use in supporting student acquisition of this technical vocabulary. Finally the report describes the language of a key piece of writing by trades students, the Builders' Diary, and shows how students' command of this writing develops over the period of study in Levels 3 and 4, when they move from on-campus study to the workplace. This report also outlines our development of resources related to each of these findings (such as technical word lists, bilingual English-Tongan word lists, and resources to support writing), and offers recommendations for practice.

"this report shows that the texts read by the trades' students in our study are lexically as demanding as university-level academic texts"

2. Aim

Our aim in undertaking this study was to provide a trade-specific description of language used in automotive technology, carpentry, fabrication and plumbing, and to describe how this language is taught and learnt at Institutes of Technology and polytechnics in New Zealand. Specifically our aim in undertaking this research was to:

- identify how much vocabulary a person needs to know to study the trades successfully
- identify the technical vocabulary of each of the four trades

- develop word lists of technical terms in the trades
- develop bilingual word lists to support the learning of Pacific learners[1]
- describe the support in learning technical vocabulary given to trades students by their tutors during classroom and on-site teaching
- investigate the expression of visual meaning in trades course books
- investigate an important discourse feature of trades teaching: the use of analogies
- describe the meanings expressed both in writing and visually in a key text written by construction students: the Builders' Diary
- describe the developmental path in the writing of the Builders' Diary between Level 3 and Level 4
- develop resources to support the learning of vocabulary (thus supporting reading) as well as resources to support the learning of writing in the trades.

Figure 1 (over page) provides an overview of the eight studies carried out as part of this project (yellow circles), including key findings and a teaching resource developed (or in development) as a result of each study (green circles).

3. Methods

This study employed both qualitative and quantitative methods to investigate trades language. Qualitative methods included: extensive interviews with trades tutors, trades professionals and trades students; observation of classroom, workshop and on-site teaching, as well as corpus-based analysis of vocabulary in use. Quantitative methods included: the building and use of a 1.6 million word corpus of written course materials, 200,000 words of student writing, and a spoken corpus of 450,000 words of classroom/workshop/on-site teaching. Quantitative corpus methods were used to identify trades vocabulary in course materials and investigate stylistic/grammatical features of student writing. See Chapter 4 for details on our methodology.

4. Findings

The studies in our project have resulted in a number of findings concerning trades vocabulary, teaching and learning, student writing and visual expression of meaning:

Trades vocabulary

Due to their technical and conceptual nature, written trades course materials have a high vocabulary load. A first finding (1st study in Fig. 1) is that students need a vocabulary of 9,000 words, in addition to the technical words in their trade, in order for them to be able to understand trades course materials. This means that the amount of vocabulary required for reading in the trades is as much as the amount of vocabulary needed to read university-level academic written texts. In comparison, the vocabulary load of spoken trades texts is much lower. See section 5.1 for more detail about this.

A second finding (1st study in Fig. 1) is based on our analysis of written corpora which shows that there are a large number of two, three, and four-word technical phrases in the trades. Learners and teachers in the trades need to be aware of these phrases and their importance in written texts. See section 5.3 for more detail.

[1] Our aim was to benefit Pacific learners in general but time and resources only allowed us to work on one language: Tongan.

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
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Figure 1: *The language in trades education project at a glance*

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The word lists developed in this research show, as a third key finding (2nd study in Fig. 1), that there is a technical vocabulary of more than 1,000 words specific to each trade. Some of these words have a general as well as a specialised meaning, indicating that students must learn to distinguish a specialised meaning from an already known general meaning for familiar words. Roughly one word in three in written trades texts is a technical word. See section 5.2 for more detail.

A fourth finding (3rd study in Fig. 1) is that there is a high number of technical trades words for which there is no Tongan equivalent. Work such as ours is necessary to develop the technical domain in the languages of small island nations. See section 5.4 for more detail.

"Roughly one word in three in written trades texts is a technical word"

Teaching and learning

A fifth finding (4th study in Fig. 1) concerns how trades students learn vocabulary. They do this by interacting with their tutors, by using the word and by tutors and learners drawing attention to the technical words in tutor-learner interaction. In this way, vocabulary learning is integrated with and integral to the learning of the trade. See section 5.5 for more detail.

A sixth finding (5th study in Fig. 1) concerns how analogies are used in the trades to explain conceptually difficult ideas, such as electrical concepts. Some analogies had been remembered from the tutors own training, while others were generated by tutors themselves. See section 6.3 for more detail.

Student writing

A seventh finding (7th study in Fig. 1) is that student writing of the Builders' Diary undergoes developmental change stylistically as students move from Level 3 (on-campus) to Level 4 (in the workplace). With changing needs and changing context, writing becomes much more concise. See section 6.2.1 for more detail on this.

An eighth finding (7th study in Fig. 1) is that the Builders' Diary expresses three key meanings. These are 'setting the context of the building work', 'detailing materials and equipment' and 'detailing the building work'. These three meanings reflect the purpose of recording information for future reference and the purpose of assessment of unit standards. See section 6.2.2 for more detail on this.

Visual meaning

A ninth finding (6th study in Fig. 1) is the diversity of course materials in trades training. Materials include pedagogical, legal and technical documents. They are complex and multimodal, with written text embedded with a range of diagrams, photographs, graphs and charts. Conceptual knowledge is made more accessible through multiple representation in text and visual modes. See section 6.4.1 for more detail on this.

Our final finding (8th study in Fig. 1) is the regularities in expression of visual meaning by the writers' of the Builders' Diaries. This provides evidence that the students share cultural understandings of expression of visual meaning and are able to use these understandings to express technical meaning appropriately. See section 6.4.2 for more detail on this.

5. Implications for practice

There are a number of recommendations for practice stemming from this research. Again we note that our recommendations are relevant to the four areas of trades vocabulary, teaching and learning, student writing and visual expression of meaning:

Trades vocabulary

As learners need a large vocabulary to understand their course materials, it would be useful to test their vocabulary at the beginning of their study to see how much support they need in reading their texts.

Learners need to be made aware of the technical meanings of technical words early on in their studies. The trades-based pedagogical word lists (see Appendix 9 for the most frequent 100 words in each of these trades lists) and the abbreviations and proper noun lists could be used in planning to help identify lexical items which will need attention during a course of study.

The bilingual English-Tongan technical word list (see Appendix 7 for the first 100 words of each of these lists) can be used to support the learning of Tongan students for whom English is a second language. Further research to make bilingual word lists in other Pacific languages such as Samoan and Fijian would ensure that students from all Pacific communities would benefit.

Teaching and learning

It is recommended that tutors plan for teaching the technical vocabulary that may arise in the classroom, as well as reflect on strategies they have used, and whether their learners have understood and used the new words. Resources showing a range of simple activities and strategies that tutors can use to integrate and support the learning of vocabulary while learning the trade have been developed ('Working around the words', available on the Ako Aotearoa website).

We recommend that care be taken in the choice of analogies used in teaching difficult concepts, as some analogies do not provide a good mapping of concrete to abstract ideas, and can result in confusion.

Student writing

In teaching the Builders' Diary, just before students move into the workplace, time could be spent on demonstrating use of a more concise style of writing which is less personal and relies on point form.

We recommend that carpentry tutors use our analysis of meanings expressed in initial teaching of the Builders' Diary, and provide resources to support their teaching for their learners ('Building writing skills guide' available on Ako Aotearoa website).

Expression of visual meaning

Resources to outline the range of visual meanings that tutors use in course material are available on the Ako Aotearoa website. This innovation may be useful to novice materials developers.

Resources to address expression of visual meaning in teaching the Builders' Diary, including image-image relations, and of image-text relations may also be useful (see 'Building writing skills guide' available on Ako Aotearoa website).

Chapter 1
Introduction

1.1 Background and rationale for the study

There is a widespread assumption that students who take up a trade do so because they have not enjoyed or excelled at school tasks which require a high level of reading and writing. For example Lehmann (2005) interviewed students in Canada and in Germany who were still at school and who were enrolled in a dual trades plus school stream. Participants reported that trades training was a logical choice for them as they were not good at school work.

Similarly, the initial study we did in preparation for this project involved interviewing 23 trades tutors in six trades. A theme of these interviews was that learners had often been advised to take up a trade because they had not excelled at school; in particular, many learners were viewed as not interested in reading and writing, and were keener on building and technical work rather than on work that involved reading and writing. This might raise the expectation that reading and writing will not form a large part of what is expected of trades students during their training. However, our project shows that this is not the case.

In fact, prior research (e.g. Ivanič et al., 2009) has shown that trades students engage in literacy tasks that are varied and demanding. To address the literacy needs of students in general, including trades students, it is well recognised that literacy development, which is embedded in the teaching of content, is more useful than stand-alone literacy development that learners need to transfer to the context of their content courses. Indeed, an approach which embeds literacy in content courses is the approach that is strongly favoured in the polytechnic sector in New Zealand.

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"In New Zealand, the value of improving literacy for trades students is viewed as likely to improve opportunities for the students and likely to be of value to the country as a whole"

In New Zealand, the value of improving literacy for trades students is viewed as likely to improve opportunities for the students and likely to be of value to the country as a whole. For example, in a number of strategic documents (Ministry of Education, 2009, 2012), the Tertiary Education Commission (TEC) argues that developing literacy is essential because it will improve workplace productivity, and thus economic and social development in New Zealand.

In order to support learning and teaching of the literacy associated with trades study, our research describes the language used in four trades (automotive technology, carpentry, fabrication and plumbing) by examining the technical vocabulary of these trades and by analysing writing, visual expression of meaning and aspects of speaking and reading in these four trades.

Much of the research on literacy in New Zealand has been in the form of government reports. A study by Whatman et al (2010 et al.) highlighted features that lead to successful literacy development in Private Training Establishments and Institutes of Technology and polytechnics. They used a case study approach to investigate the strategies and tasks tutors were using to embed literacy into content teaching. Similarly, work by Workbase (n.d., b) identified task descriptors for learning in some trades in New Zealand. Our research extends this work and describes the vocabulary and discourse features of language typically used in the trades in our study. We anticipate that our description of this language will benefit teachers and trainers to help learners acquire trades language.

With regard to development of materials, Chrisp and Reid (2002, p. 5) emphasise the importance of vocabulary learning; they developed a dictionary for a New Zealand paper mill workplace. Our description of the vocabulary used in trades teaching builds on this and has supported development of materials specific to each trade, as well as providing a key resource for further development by tutors themselves.

One New Zealand Department of Labour study that identifies strategies to address literacy issues is an evaluation of modern apprentices' literacy learning in the workplace (Sligot et al., 2010). The strategies they propose include ensuring literacy tuition is relevant to trade-specific learning goals; while outcomes included much faster progression in achieving vocational study gains and enhancements in reading, writing and numeracy. A note of concern that this report raised was that mastering the occupational specific vocabulary and knowledge was particularly challenging for learners. This was mentioned by the students who were interviewed for this study; of particular concern to them was the quantity of specialised words that learners need to be able to understand and use in a trade-specific context. Similarly, interviews with tutors raised the learning of technical words as a difficulty for students. In New Zealand, the national literacy benchmark for literacy, which sits at step 4 on the Learning Progressions for Adult Literacy Framework (TEC, 2008), involves being able to understand and use more specialised words. These findings all point to the importance of research which identifies and describes this complexity, as well as developing strategies to simplify acquisition of this language.

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Two studies that look at literacy development in trades training in New Zealand focus on reading skills (Bracey & Cross, n.d.) and explicit teaching of sentence construction (Wood, n.d.). Similarly, Benseman, Sutton, and Lander (2005) review literature on adult literacy initiatives, but do not focus on vocational learners. Of relevance to our study is their finding that it benefits learners if the curriculum is linked to the demands of their lives. This is mirrored in other Department of Labour research by Cameron, Hipkins, Lander and Whatman (2011), that literacy learning is most likely to transfer to the workplace if it is connected to the learners' 'real world'. Our research, which focuses on the vocabulary and discourse strategies found in trades talk and writing, builds on this important finding.

However, experiences of the 'real world', which Cameron et al (2011 et al.) refer to, vary, depending on student cultural and language background. Although all students start with little or no knowledge of trades language, acquiring this register in a second language is likely to be more challenging. We are interested in Pacific learners' experience of learning trades language, and how this learning can be facilitated.[1]

A number of studies focus on the workplace. For example, Workbase case studies (n.d., a) have developed important vocabulary-based resources for particular workplaces such as aluminum production, building materials, paper mills, plastics, etc. Workbase case studies stress the importance of visual literacy, another element that our work considers (see chapters 3 and 6). Literacy development in the New Zealand workplace is the focus of literature reviews by both Gray (2006) and Kell, Guy, Hastwell and Harvey (2009). Ryan, McDonald, Sutton and Doyle (2012), in their evaluation of Industry Training Organisation literacy projects, make recommendations for a focus on vocabulary and also for greater use of diagrams in teaching. Both of these are key elements in our study.

To date, the resources that have been developed are predominantly case studies of good practice. There have also been resources made available to support an embedded delivery of health and safety unit standards and a breakdown of the vocational literacy and numeracy demands of various trades (Workbase, n.d., b). Our research builds on this to provide a body of resources specific to the literacy and language demands of the four trades on which we focus: automotive technology, carpentry, fabrication and plumbing. Although the literacy and numeracy progressions have provided a framework for identifying the literacy demands of trades, these are a generic framework that does not help tutors or institutions to identify the subject-specific language requirements of each trade. This project identifies some of the specific language demands of trades courses and develops a body of resources that can be used nationally by all trades training providers to address the literacy needs of their learners.

[1]As indicated above, we would have liked to have worked on a wider selection of Pacific languages, including Samoan, Fijian and Cook Island Māori, but time and funding did not allow this. Similarly a focus on Te Reo Māori would have been interesting and beneficial. These are directions for further research

1.2 Research objectives

In its original conception, our research aimed to provide a description of language use, both spoken and written, in four trades: automotive technology, carpentry, fabrication and plumbing. We aimed to consider two aspects of this language use: both vocabulary and discourse features of trades language. In addition we wanted to investigate how trades students acquire technical language in the context of the classroom, workshop or building site. Finally, we aimed to consider the implications of learning a technical register, with specific focus on this process for Pacific learners. Our research objectives as stated in our project proposal were:

1. To identify the vocabulary of trades-specific texts, whether spoken or written.
2. To identify the organisation and discourse patterns of spoken and written genres.
3. To investigate the role of visual elements (e.g. graphs and diagrams) in trades text and talk.

A further implied objective was:

4. To identify the literacy and language demands of trades language, with a specific focus on Pacific learners.

In addition, our pedagogy-related objectives were:

5. To develop a range of teaching and learning resources.
6. To disseminate our findings to support trades tutors' teaching of trades-specific language.

Having reached the end of this 3-year project, we have by no means exhausted the fields that these research objectives led us to explore. Our research does however shed light on each of areas 1-4 above, and we have completed an in-depth study on each of them. We briefly outline below the extent to which we have reached each of the above objectives

With regard to the first objective (identifying trades-specific vocabulary), although we aimed to investigate vocabulary in both spoken and written modes in the trades, our focus on written language to date is more complete than our focus on spoken language. One reason for this is that spoken data takes far longer to collect and process than written data. In addition, the written trades documents contain far greater amounts of technical vocabulary than the spoken texts. However, our spoken corpus (450,000 words) is now complete and work on this will continue in the future. With regard to written language, our research has resulted in a description of technical trades vocabulary. We have produced frequency-based lists of technical vocabulary in four trades, based on our 1.6 million word corpus of written course materials in these four trades. We anticipate that these lists will be useful to trades tutors, as they identify those words that distinguish trades language from everyday language, making it easier for trades tutors to prepare glossaries, and to identify the vocabulary that is likely to cause difficulty. To date one research article has been published on this work (Coxhead, Demecheleer & McLaughlin, 2016), and a further article (Coxhead & Demecheleer, under review) and a chapter (Coxhead, under review, a) have been completed.

With regard to objective 2 (discourse patterns of spoken and written genres), a small-scale investigation of the spoken mode relates to the use of analogies in trades teaching. We have presented at a conference on this area (Mackay, 2014). With regard to the written mode, we have focused on a key text written by students in the construction trades, the Builders' Diary. This is a daily account of building work which is written by professionals in the construction industry. Carpentry students also produce this as part of their training. Our description extends

to the meanings expressed in the Builders' Diary, the language used, and how this changes from diaries produced by on-campus pre-trade students to diaries produced by apprentices working in industry. Use of diary writing has been piloted in other trades (e.g. automotive technology), so we project that this study will be of use in teaching writing in these trades as well. To date one research article (Parkinson, Demecheleer & Mackay, 2017) has been published on this work, and a further article has been written (Parkinson, Mackay & Demecheleer, in press).

In addition, we have investigated the expression of visual meaning in the Builders' Diary in photographs and sketches (objective 3). We anticipate that this study will be of use to carpentry tutors and to ESOL tutors who work with carpentry students. To date, one research article has been written on this work (Parkinson, Mackay & Demecheleer, in review). A further area of research, relating to objective 3, concerns multiple representations of the same material (e.g. graph, text and diagram) in trades course material and classroom teaching. We have presented at a conference on this study (Mackay, 2015).

Three studies by our team relate to objective 4 (the literacy and language demands of trades language, with a specific focus on Pacific learners). The first study drew on a wide range of interviews with tutors to identify their perspectives on the literacy demands of trades study. It also involved a consideration of the reading and writing that trades students do. This initial scoping exercise resulted in one publication (Parkinson & Mackay, 2016).

The second study to consider the literacy and language demands of trades language (objective 4) investigated how trades tutors address the teaching of vocabulary in classroom and on-site teaching. Episodes of incidental focus on vocabulary by tutors and students, while they are engaged in teaching and learning concepts or processes, are identified. This analysis of strategies used by four experienced trades tutors will be useful to tutors who are new to teaching. This study resulted in a research article (McLaughlin & Parkinson, in review).

Our third study to address the literacy and language demands of trades language, with a specific focus on Pacific learners (objective 4), involved the development of English-Tongan bilingual technical word lists in the four trades. This research will be useful for trades tutors and students in both New Zealand and Tonga, and in addition, it documents the technical domain in Tongan, which is of value in supporting the vitality of the language. An equivalent English-Samoan word list is planned. An article on this study is currently being written (Coxhead, Parkinson, & Tu'amoheloa, in press).

With regard to our fifth, pedagogy-related, objective, involving the development of teaching and learning resources, the resources in Table 1.1 have been or are being developed:

Table 1.1: ***Teaching and learning resources developed in connection with objectives 1-4***

Objectives	**Objective 5:** To develop teaching & learning resources.
Objective 1: To identify the vocabulary of trades-specific texts, whether spoken or written.	**Completed** • Technical vocabulary word lists in 4 trades • Tutor reflection tool to support vocabulary development (See 'Working around the words' available on Ako Aotearoa website) • 3 x videos ('60-second solutions') • Guidelines for developing glossaries for tutors (See 'Working around the words' available on Ako Aotearoa website)
Objective 2: To identify organisation & discourse patterns of spoken and written texts.	**Completed** • A set of teaching and learning resources for writing Builders' Diaries and guidelines to their use. (See 'Building writing skills guide' available on Ako Aotearoa website) • 6 x videos ('60-second solutions')
Objective 3: Investigate expression of visual meaning in trades texts.	**Completed** • Resources on interpreting engineering drawings and expressing visual meaning for learners
Objective 4: To identify the literacy and language demands of trades language, with a specific focus on Pacific learners.	**Completed** • Bilingual English-Tongan word lists in 4 trades • Posters demonstrating teaching strategies for tutor professional development (See 'Working around the words') • Professional development resources for tutors teaching in Pasifika trades programmes including 2x videos, 1x poster and a section in the guide for organisations (See 'Working around the words' available on Ako Aotearoa website) • A complete guide for organisations: *Working around the words: unpacking language learning in trades training* which pulls together the resources and offers guidelines for organisations to build tutor capability to embedding language development in trades programmes

With regard to our sixth objective, also pedagogy-related (to disseminate our findings to support teaching of trades-specific language), we have, over the last three years, made 26 presentations at conferences. These presentations have been divided between local conferences in the field of vocational education (7), local conferences in the field of language teaching (10) and international conferences in the fields of applied linguistics (7) and science and technology education (2). A list of these conference presentations is included in Appendix 1.

Chapter 2
Literature review

Our project arises from the recognition that learning a trade involves acquiring a new technical vocabulary, without which a student cannot become a true member of the trade. As one of our informants, a carpentry trades tutor, said:

> You look like a builder, you walk like a builder, you might as well talk like a builder [...] and that way we can get into the conversation, how builders talk [...] builders have their own sort of language

We note also that the reading required of trades students is quite extensive, and that although less extensive, a certain amount of writing is also expected. However, almost no work has been done to characterise and describe the nature of this talking, reading and writing. The focus of our project is, therefore, to describe the language of the trades, and give some insight into how this language is taught and learnt. To explore this defined focus, the team of researchers we have brought together to undertake this investigation are deliberately diverse in their perspectives and expertise. The areas of literature on which we as researchers draw in the studies we contribute to the research are therefore also diverse. In this chapter we review literature relevant to the related studies with which we address the objectives outlined in the previous chapter. These fields include: language and literacy (section 2.1) particularly in vocational education; literacy and tutor support (2.2); vocational education in the Pacific (2.3); vocabulary (2.4), particularly with regard to technical language; genre analysis (2.5); analogies in the teaching of science and technology (2.6); and finally literature concerning visual meaning (2.7).

2.1 Language and literacy in vocational education

Teaching of literacy in the trades at Institutes of Technology and polytechnics in New Zealand can be viewed as part of a process of socialisation of students into their trade, in which they learn the trade knowledge, and trades skills, at the same time as learning the literacy practices of the trade. Polytechnic students are not taught separate language skills with the aim that they can be transferred from one context to another. Instead, they learn the literacy of their trade while learning the trade. This is coherent with the New Literacy Studies' (Lea & Street, 2006) view of the process of literacy acquisition as one of socialisation. This approach in which acquisition of literacy is 'embedded' in content acquisition has been found to improve retention and success rates, and better prepare students for the workplace (Casey et al., 2006).

This 'embedding' of literacy into trades content is strongly supported by the Tertiary Education Commission (for example, Tertiary Education Commission, 2008; Ministry of Education, 2009, 2012). Indeed, the 'Learning Progressions Framework' (Tertiary Education Commission, 2008) underpins much of the language and literacy development in Institutes of Technology and polytechnics in New Zealand. The purpose of this framework is to guide and benchmark adult language and literacy development and it is used as the basis for diagnostic and progression assessment and to inform teaching and learning, especially in vocational education. Within this framework, there are six 'steps' (Tertiary Education Commission, 2008) through which learners need to progress in order to meet the national benchmark of having sufficient language and literacy skills to interact in a range of unfamiliar situations. These six steps intersect four literacy 'progressions': reading, writing, listening and speaking. Vocabulary is the one area of language use that occurs across all four progressions. As an aspect of this framework that is of relevance to the study of technical trades' language, the national benchmark of step 4 for vocabulary involves learners being able to use and understand specialised words in specialised contexts (Tertiary Education Commission, 2008).

installation consortium supply reinforcing bearing
flow frame formwork accordance bracing angle specifications compound fixing construction foundation voltage

Our notion of what constitutes literacy includes the multiple ways that participants make meaning in their trades including text, talk, visual expression of meaning (such as photographs, drawings, graphs, etc.) and mathematical expression of meaning (e.g. calculations). In learning to communicate meaning in trades-specific ways, students are learning a new trades-specific register of English, and are also learning the cultural norms and values that are specific to their trade.

Literacy in the trades has been found to be varied and complex. Ivanič et al (2009 et al.) used ethnographic methods to investigate the literacy practices of a range of trades training including childcare, hospitality, painting and decorating and bricklaying. Edwards, Minty and Miller (2013) studied hospitality training and found that students produced a wide range of text types, and that assessment drew on both academic and workplace genres. Smith et al. (2008) found a high level of complexity in the study of childcare, including literacies that are not found in the workplace.

Although these studies show trades literacy to be complex, Cooper and Baynham (2005, p. 7) found that many construction students in their study had been recommended to take up a trade because of their limited success in text-related tasks at school. They found that a range of values, beliefs and expectations, stimulated by class, culture and family expectations, oriented students to take up a particular vocation and the identity associated with that vocation.

The issue of identity is an important one, and being able to communicate appropriately in the language associated with the trade is an important element of identity in the trade. Holmes and Woodhams (2013) studied the role of verbal interaction, including the role of humor, in teaching

apprentices the norms of the construction community and acculturating them into the community.

Coming to share the values and culture of a trade are important in becoming a trades professional, because this involves acquiring not only skills and knowledge, but also professional practices (such as the Builders' Diary, see Chapter 6) and professional identities. For trades trainees, whether in the educational institution or in the workplace as apprentices, their interaction with experienced professionals, such as their tutors, employers and workmates, facilitates the learning of trades values and identities. For example, Chan (2014) found evidence that the ethos of the workplace (for example, a workplace focus on profitability or on quality) has a strong influence on (bakery) apprentices' development of occupational identities. Chan's (2016) study of apprentices in a range of trades also found that identification with and sense of belonging in a workplace fostered a sense of identity in the trade.

"...being able to communicate appropriately in the language associated with the trade is an important element of identity in the trade"

In analysing how apprentices acquire workplace values and identities, Vaughan, Bonne and Eyre (2015) use the concept of 'vocational thresholds'. These are learning experiences that transform the trainees' sense of their trade as a whole and of their identity and role within the trade. For the carpentry apprentices in their study, Vaughan et al. (2015) identified as vocational thresholds attitudes and values, such as taking pride in their craft and integrating judgement and a sense of the aesthetic value of their work, with technical ability.

Filliettaz (2010) found that social and interpersonal issues are important in vocational training interactions; if apprentices fail to learn to display an authentic identity through talk, this can lead to marginalisation of the apprentice. Necessity to display an authentic identity through appropriate talk is evidenced too in a study by Vaughan, Kear, and MacKenzie (2014), who report on a meeting between a carpentry apprentice, his employer and a training assessor, in which the apprentice failed to display, through talk, a convincing identity as a carpenter. They report that 'the apprentice struggled to demonstrate real understanding of plans and specifications. He could describe his recent actions on-site but not the principles and reasoning behind them' (Vaughan et al., 2014, p. 334). They ascribe part of the problem in this instance to the context of the assessment, which took place apart from the apprentice's familiar on-site environment.

In trades training, much of the teaching and learning draws on an apprenticeship approach, a form of socially situated learning, in which students learn from a more experienced other through practice. This facilitates the learning of the specialised language of the trades, because in the words of Lave and Wenger (1991, p. 85) 'Language is part of practice, and it is in practice that people learn'. Thus it is important to investigate the context of practice in which students learn trades language. We consider this in the next section.

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

2.2 Literacy and tutor support for vocabulary learning

In this section we consider how learning trade-specific language manifests itself within the practice of a trades training context. There is a paucity of literature focused on teaching and learning vocabulary in vocational and specifically trades training contexts. In the vocational training context in the UK, a number of studies have looked at aspects of literacy acquisition in a trades context. These include Roberts et al. (2005), who considered characteristics of embedding language, literacy and numeracy (LLN) teaching in content teaching; Casey et al. (2006), who investigated how LLN could be embedded into vocational programmes and its impact on learning and achievement; and Atkin, Rose, and O'Grady (2007), who considered the use of centrally developed embedded LLN resources by practitioners. LLN that is embedded in content teaching involves combining development of these skills with vocational and other skills so that learners are able to succeed in their study, everyday life and work (Latham, 2010). Although none of these studies specifically focuses on the teaching and learning of vocabulary, they emphasise that learning language and literacy has to be fully contextualised, using an approach in which LLN is embedded in content teaching; language and literacy development needs also to focus on subject-specific goals. As Casey et al. (2006, p.42) state, language and literacy need to be 'explicitly taught, but in ways that learners perceive are clearly integrated within their own vocational motivations and aims'. Therefore, language learning needs to happen through the vocational training, to involve explicit teaching, but in ways that show a clear link between the learning of the language and the learning of the vocation itself.

In the New Zealand vocational education context, there has been some research related to language and literacy development. Examples include reports engaging young people in LLN (Whatman et al., 2010), evaluations of literacy projects (Ryan, McDonald, Sutton, & Doyle, 2012), literature reviews (Gray, 2006; Benseman, Sutton, & Lander, 2005) and engagement of workplaces in funded literacy projects (Kell, Guy, Hastwell, & Harvey, 2009). Although none of these studies focus on learning vocabulary in a trades training context, they do describe language and literacy development in the local context and raise a number of points. For example, Whatman et al. (2010, p. 43) found that '[t]he literature we reviewed was very clear that embedding LLN into vocational course was the best approach. The literature was less clear on the nature of that embeddedness'. So although, as in the UK context, an embedded approach is advocated, what exactly this means in terms of language and literacy development is unclear. Sligo et al. (2010), in their evaluation of modern apprentices' learning did identify strategies to address literacy issues, for example, ensuring literacy tuition is relevant to the trade-specific learning goal. But they also recommended further investigation to identify a 'means for embedding … literacy learning into trade/technical learning' (Sligo et al., 2010, p. iv). Therefore, although language and literacy related research in vocational contexts does advocate the strong link being made between development of language and literacy and the vocational practice itself, none of these studies appear to address how technical vocabulary is taught and learnt in trades training contexts. Our study (McLaughlin & Parkinson, in review) addresses this gap.

It is valuable to learn the most frequent and useful vocabulary items of that specific context to support language and literacy development and enable learning of the subject matter knowledge (see section 2.5 below on technical vocabulary). Finally, there have also been a number of studies focused on identifying instances when tutors draw attention to language, again in academic contexts, but within content-focused instruction (Costa, 2012; Basturkmen & Shackleford, 2015). Although all of these studies offer insights into the teaching and learning of

specialised words, none of them addresses the specificities of learning the specialised words of a trade within the trades training context itself.

2.3 Vocational education in the Pacific

Like newcomers to all technical fields, trades students are acquiring new skills and new cognitively demanding concepts. To enable them to talk about these new concepts, they are learning a new technical register of English. However, learning this new register in a second language adds a layer of complexity to trades learning (Taboada, 2012; Ardasheva & Tretter, 2017).

Twenty five percent of the population of New Zealand was born outside the country (Statistics New Zealand, 2014), and for many migrants, English is not their first language. A number of trades students are migrants, some from Asian countries, but most from Pacific islands.

With regard to students for whom English is a second language, we focus in this report on Pacific students, who form the majority of students for whom English is a second language in the trades at the institution in which the study took place. Statistics New Zealand (2014) reports that in 2013, 7.4% of New Zealanders identified as having Pacific ethnicity, and a third of these had been born outside of New Zealand. However, the proportion of ethnically Pacific students studying the trades is higher than this implies, as witnessed by the fact that one of four carpentry classes in 2014, the year we collected our data, was a Pacific trades class.

Both Samoans and Tongans speak English as a second language rather than as a foreign language. This is because English is the medium of instruction in high school, in both Tonga (Murray, 2010, p.39) and Samoa (Biewer, 2015, p.15). In both Tonga and Samoa, the vernacular language is the medium of instruction in primary school, a beneficial model of bilingualism (C. Baker, 2006) that allows literacy to be established in the mother tongue first. However, Lotherington (1998) notes that, despite an official switch to English at high school level in Tonga and Samoa, in many classrooms, the learners' first language is often retained as the de facto medium of the classroom. Like other post-primary education, vocational education in Samoa and Tonga is through the medium of English, but once again the learners' first language may be used in vocational classrooms.

Despite the beneficial model of bilingual education in both Samoa and Tonga, the post-primary shift to English is claimed by Taufe'ulungaki (1999) to stem from the perception that the vernacular language does not yet have a developed scientific and technical vocabulary, and is 'incapable of expressing complex, higher level concepts and abstract notions' (Taufe'ulungaki, 1999, p. 2). This is self-fulfilling to the extent that such development is less likely to happen if a language is not used to make scientific and technical meanings. Indeed modernising terminology and extending it into technical domains is viewed by linguists (e.g. C. Baker, 2006, p. 50) as essential for language vitality. In one strand of our research in this project (see section 5.4) we contribute to extending

"...the proportion of ethnically Pacific students studying the trades is higher than this implies, as witnessed by the fact that one of four carpentry classes in 2014, the year we collected our data, was a Pacific Trades class"

Tongan into this technical domain, by providing a bilingual English-Tongan word list. A similar bilingual word list is planned for Samoan.

Despite the fact that both Samoa and Tonga are agrarian economies, their geographical isolation means that vocational education is important to produce skilled trades people who can fulfil local demands for carpentry, plumbing, metalwork, etc. Ideally such vocational education could lead to the establishment of a manufacturing sector for export, a possibility that Baldacchino (2006) views as one factor that would enable small islands to move away from heavy reliance on remittances from relatives working in other countries, on migration and on aid.

Difficulties of translating vocabulary

A number of well-recognised difficulties in translating vocabulary are noted by M Baker (2011). These include the fact that there is no one-to-one correspondence in meaning between words in different languages. Meanings in one language may require a single word but more than one word in another (M. Baker, 2011, p. 10). In addition, a word may not be lexicalised in one language. Because our study focused on technical words, many of which have developed in English relatively recently, this was a prominent factor in the translation of our technical word lists into Tongan.

2.4 Technical language

Knowledge of a subject area is closely tied to the technical vocabulary of that subject (Woodward-Kron, 2008). Coxhead, Demecheleer, and McLaughlin (2016) point out that it is difficult to talk with builders without using words like *'measurements, timber* or *moisture'*. Much research into technical vocabulary has focused on English for Academic Purposes (EAP) where the main concern has been to identify the lexis which learners might need when going into a range of subjects in university study (Coxhead, 2000; Gardner & Davies, 2014) or into a particular area of study, such as Hirsh and Coxhead (2009) and their list of science-specific vocabulary.

Research into technical vocabulary in specialised subjects has used different measures to identify and quantify this vocabulary. Chung and Nation (2004), for example, evaluate four different methods for identifying technical vocabulary in the field of anatomy, including consulting technical dictionaries, using a semantic scale, and using a corpus. The scale method (outlined in more detail in Chung & Nation, 2003) involved categorising words according to levels of technicality, from one up to four. Step Four on the scale indicated the highest level of technicality, meaning these words only occurred in the specialised area (for example, anatomy) and not in any other subject or general language use. Step One means there is no relationship between the target words and the technical subject. Chung and Nation (2003) found that one word in three (30%) in the anatomy text was technical in nature. They carried out the same scale study using an applied linguistics text and found that 20% of the vocabulary in the text was technical in nature. Little research has examined the technical nature of vocabulary in the trades, and our study contributes to addressing this imbalance in the literature.

2.5 Genre analysis studies

A number of the studies in this project are placed within the field English for Specific Purposes, which is a field of language teaching that focuses on addressing the language needs of tertiary students for whom English is a second or additional language, and who need the language for

occupational or educational purposes. Within this field of language teaching, Swales's (1990) 'move' analysis has been influential as it allows the analyst to identify the kinds of meanings that are expressed in particular occupational texts (e.g. company audit reports (Flowerdew & Wan, 2010)), or educational texts (e.g. science laboratory reports (Parkinson, 2017)). In his influential analysis of research article introductions, Swales identified three moves: *Establishing a territory* (for example, by reviewing previous literature); *Establishing a niche* for the research (for example, by noting a gap); and thirdly by *Occupying the niche* (for example, by outlining the purposes of the research). Since then much attention has been paid to other sections of research articles such as results sections (Bruce, 2009) and discussion sections (Basturkmen, 2012). Other genres have also been investigated, such as grant proposals (Connor & Mauranen, 1999), and company audit reports (Flowerdew & Wan, 2010). In this report we provide a move analysis of the Builders' Diary genre, a study described at greater length in Parkinson, Mackay and Demecheleer (in press).

2.6 Explanations and analogies in trades teaching

The use of analogies in teaching is widespread, and trades teaching is no exception. Since many engineering related trades have a scientific basis (more specifically, in physics), we draw on the work done in understanding the role of analogies in teaching physics as a basis for our understanding of the role of analogy in teaching trades such as automotive technology, electro-technology and plumbing. An early example of analogical thinking is provided by Maxwell, (1855, p.367) who said:

> Instead of using the analogy of heat, a fluid, the properties of which are entirely at our disposal, is assumed as the vehicle of mathematical reasoning...The mathematical ideas obtained from the fluid are then applied to various parts of electrical science.

Two purposes have emerged in the literature for the use of analogies in teaching. The first is the obvious purpose of communication of ideas. It is clearly the case that analogy use in our study has this as its main purpose, because the use of an analogy based in something concrete which the learner already knows, will help to clarify more abstract ideas by mapping the ideas from the more concrete base domain to the more abstract target domain. The second purpose has been a generative one, where analogies have been used by scientists to describe new and unknown systems in more concrete terms; this is clearly not the purpose in our data.

In our analysis, we use the ideas of Gentner (1983), who described analogies in terms of a mapping from a base domain, where things were well understood (and perhaps more concrete), to a target domain, where the concepts were more abstract. He identified three categories of metaphor; a literal similarity, an analogy and an abstraction. Lakoff (1993) went further to say that the cross domain mapping is part of the conceptual system and that it is also part of the way we make sense of the world. In other words, gaining an understanding of the mapping will enhance the learners' conceptual understanding.

2.7 Studies of visual expression of meaning in technical writing

The visual mode is widely used to express meaning in technical writing, where it assists in expressing complex cognitive concepts. A number of studies over the last few decades have focused on visual meaning in technical documents, and like our study (see Parkinson, Mackay & Demecheleer, in review), most have employed Kress and van Leeuwen's (1996) grammar of

visual design. For example, Rowley-Jolivet (2004) compared the images used in conference presentations in three different scientific disciplines. She found that professionals in different disciplines used different technologies for expressing visual meaning.

Another relevant study is that by Karlsson (2004), who compared industrial drawings by architects and engineers to the images in do-it-yourself magazines. She found the images in the do-it-yourself magazines to be more 'realistic' than the industrial drawings, which were line drawings. The images in do-it-yourself magazines were heavily supported by text, while the industrial plans contained the line drawing only, with very little text.

Studies of educational genres include one by Bezemer and Kress (2009) of images in English textbooks between the 1930s and 2000s. They found enormous growth in the number of images used, from 0.03 per page in 1930, to 0.74 per page by the 2000s. An important innovation was that they found the modern textbooks to be organised by use of images. Jewitt's (2002) study of how recontextualising a novel into a CD-ROM simplified and restricted the interaction of the readers with the text is also relevant. Wilson and Landon-Hays (2016) studied visual meaning in another educational genre: the images used for teaching by six middle-school teachers in a range of disciplines.

"There have been relatively few studies of student technical writing, such as our study of visual meaning in the Builders' Diary, which we describe in section 6.2"

There have been relatively few studies of student technical writing, such as our study of visual meaning in the Builders' Diary, which we describe in section 6.2. One such study, by Varpio, Spafford, Schryer and Lingard (2007), considered the writing by trainee optometrists of patient records. Unlike the Builders' Diary, which allows fairly free expression of meaning by the carpentry students, the optometry patient record is highly constrained and structured, more like a printed form which is filled in by the student optometry practitioner. Varpio et al. (2007) found that this optometry patient record encouraged expression of the scientific voice rather than foregrounding patient-provided information. Builders' Diaries themselves have been considered by Vaughan, Gardiner & Eyre (2012), but largely in the context of assessment rather than as part of acquiring control of a technical register of English, as in our study.

2.8 Summary of chapter

This section has discussed literature relevant to our study. We have outlined the limited prior research on trades literacy, noting that although trades teaching in New Zealand follows a useful model in which literacy teaching is 'embedded' in content teaching, prior research on how this should be done is limited. We have also outlined research on vocational education on the Pacific islands of Samoa and Tonga, because, given extensive migration from these islands to New Zealand, and the numerous students from these islands enrolled in trades study in New Zealand, this is relevant to the context of our study. We have outlined, too, prior research on technical vocabulary, noting that no prior work exists on the technical vocabulary of the trades. This section has also provided a brief sketch of work on genre, specifically 'move' analysis, which is relevant to the investigation of trade student writing which we undertook in this research project. We have briefly considered prior research on analogies, which are important in trades teaching, both in the classroom and in printed course material. Finally, we noted prior studies of expression of visual meaning, particularly in trades and educational contexts.

Chapter 3
Theoretical Frameworks

In this section we outline three theoretical frameworks that we rely on in different parts of this report. These frameworks are: genre theory for the analysis of discourse in the trades (section 6.2); Kress and van Leeuwen's 'grammar' of visual meaning (section 6.4), and the Talanoa research methodology for the development and analysis of bilingual word lists (section 5.4).

3.1 Genre theory

Genre theory, the framework that we use to interpret the Builders' Diaries in our study, is a central framework in the study of written and spoken text. It has been widely used in the analysis of writing done in academic settings. A genre is a set of texts, whether spoken or written, which function to fulfil a particular purpose and have a regular form which is familiar to and expected by the audience to whom the genre is addressed. Examples of genres are argumentative essays, pop songs, sermons, curriculum vitae, manufacturers' specifications, and funding proposals. We use the everyday example of the curriculum vitae (CV) to explain the idea of genre. The purpose of the CV is to get the writer a job, by telling the reader the relevant education and experience of the writer. The purpose of communicating relevant education and experience is what Swales (1990) refers to as communicative purpose (what the writer/speaker is communicating to the reader/listener); in the example of the CV this refers to the writer's education and experience. In addition, genres have what Martin (2009) calls social purpose (what the writer or speaker is trying to do in the social world); in the example of the CV this refers to the writer's desire to get a job. As expected by the readers of the CV (potential employers), the form of the CV is highly structured and regular.

People learn the formal aspects of genres – their organisation, level of formality, and stylistic features – by repeated exposure to instances of the genre (Miller, 1984; Tardy, 2011). Genres are also culture-bound (Martin 1984), where culture can refer to national or social groupings, as well as to disciplinary culture. In the case of our study, culture refers to the norms, beliefs and ways of viewing the world that are common to a particular trade, for example the culture of the construction industry. Examples of genres in our study are the Builders' Diary genre, as well as classroom teaching, and manufacturers' specifications.

In our study of the Builders' Diary, described in section 6.2, we drew on 'move' analysis, an analytical tool developed by the genre theorist, John Swales (1990). Swales, like Martin (1984), noted how genres are organised in recognisable stages, almost like the 'moves' in a dance. Each move in a genre fulfils a particular purpose and together the moves work together to fulfil the overall purpose of the genre.

3.2 The 'grammar' of visual meaning

A second theoretical framework we draw on in this study is that of Kress and van Leeuwen's (1996) 'grammar' of visual design. This framework has been highly influential in the analysis of images. We used this in our analysis of the visual meaning in the photographs and drawings in the Builders' Diary. This draws on the field of social semiotics (Halliday, 1978), which stresses the social and cultural context of language, and views language as one way of making meaning amongst many others (e.g. film, art, drama, music, gesture, etc.). Kress and van Leeuwen (1996) considered the way that meaning is also made visually. They explored the way that regularities to be found in how we express meaning visually reflect culturally-shared ideas. Just as we read a text from left to right in the western tradition, they note how images too are 'read' from left to right. Social semiotics views different ways of expressing something in words as choices

between options that the writer/speaker draws on depending on audience, context, level of formality, etc. Similarly, different ways of depicting something visually (e.g. photograph vs. drawing, or close-up vs. long shot, etc.) can be viewed as choices made by the producer of the image. One of the ways that van Leeuwen (1991) extended Halliday's social semiotics was in considering how textual and visual meaning interact; this is an aspect that we draw on in our study.

Of relevance to our study is Halliday's (1994) view of language, also employed by Kress and van Leeuwen (1996), as serving three overarching functions (known as metafunctions). These are what a text/image is about (the representational metafunction), the relationship in a text or image between speaker/writer/producer and listener/reader/viewer (interpersonal metafunction), and how the text/image is organised (the textual/compositional metafunction).

In what follows, we outline aspects of Kress and van Leeuwen's (1996) framework that we employed in our study. A fuller explanation of the framework can be found in Parkinson et al (in review).

With respect to what the image is about (representational meaning) we recorded whether each image, whether photograph or sketch, included people (for ethical reasons we include no photographs with people), or did not contain people. Relationship in the images between the producer and viewer (interpersonal meaning) was coded for each image by considering whether the image 'offered' information (images 3.1-3.7) or 'demanded' social recognition of a human subject who made 'eye contact' with the viewer (Kress & van Leeuwen 1996, p.124).

A number of aspects of how the image is organised (compositional meaning) were also coded. These included where on the page the image was placed with respect to text or other images (left-right; top-bottom). Just as in a written sentence or spoken utterance writers generally place 'known' information first in the sentence and 'new' information second, so on a page containing image and text, when the producer places the image on the left, we can assume that this is regarded by the producer as given or known information and the text on the right as new information (Kress & van Leeuwen 1996, p.186). We see this left-right orientation in Figure 3.1. In contrast, if the producer places text to the left and the image to the right, we project that the producer regards the text as known and the image as new (Fig 3.2).

Broke out old Concrete Stairs along House
So can look up and put new Concrete ramp
Using Kango breaker.

Figure 3.1: ***Photograph in 'given' position and text in 'new' position***

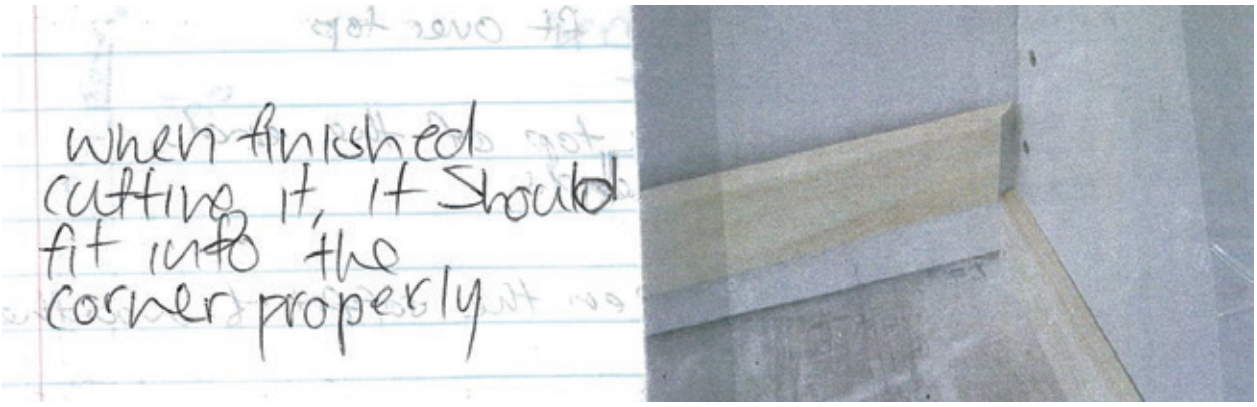

Figure 3.2: *Written text in given position and photograph in new position*

Kress and van Leeuwen (1996, p.193) view image or text which is at the top of the page as reflecting the producer's view of this text/image as being in 'ideal' position, and image or text at the bottom as in the 'real' position. In Figure 3.3, the sketch at the top of the page may be regarded as ideal – perhaps what the diary writer planned before doing the work. The photographs at the bottom are real – what the producer actually did.

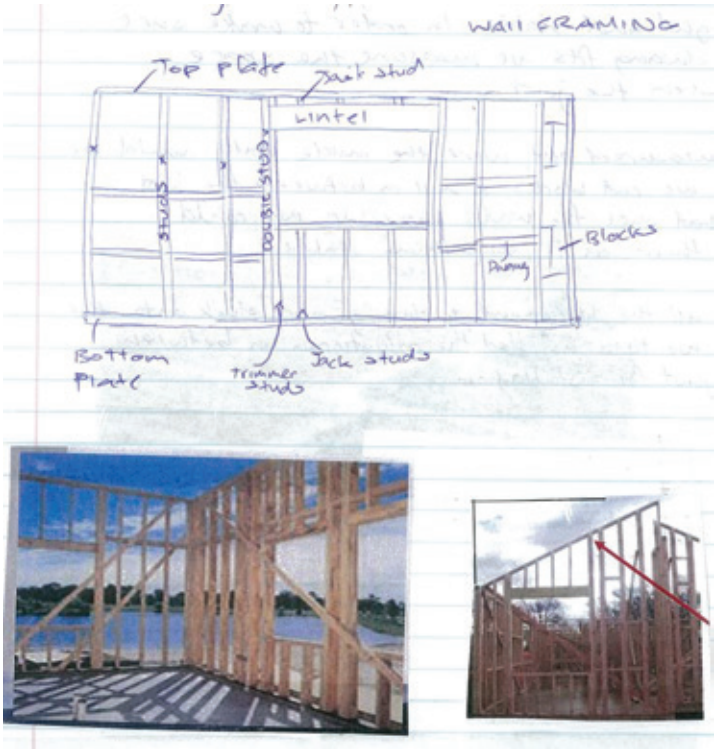

Figure 3.3: *Photograph in 'real' position and sketch in 'ideal' position*

A second compositional feature we included in our analysis was the relationship of each image to other images. Different relationships in which images were found included:

- A relationship showing changes over time. An example is found in Figure 3.4, which includes two images showing the stages in removing an old staircase and installing a new one.
- Spatial relationship. An example is found in Figure 3.5 in which two sketches show different perspectives and details of a window.
- Overview-detail relationship. An example is shown in Figure 3.6 where the sketch to the right is a detail of the sketch on the left.

Figure 3.4: ***Sequence of photographs showing changes over time***

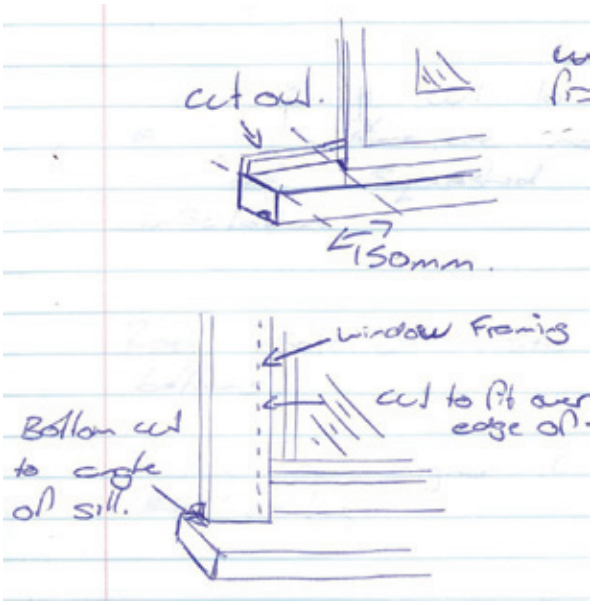

Figure 3.5: ***Two images indicating spatial relations***

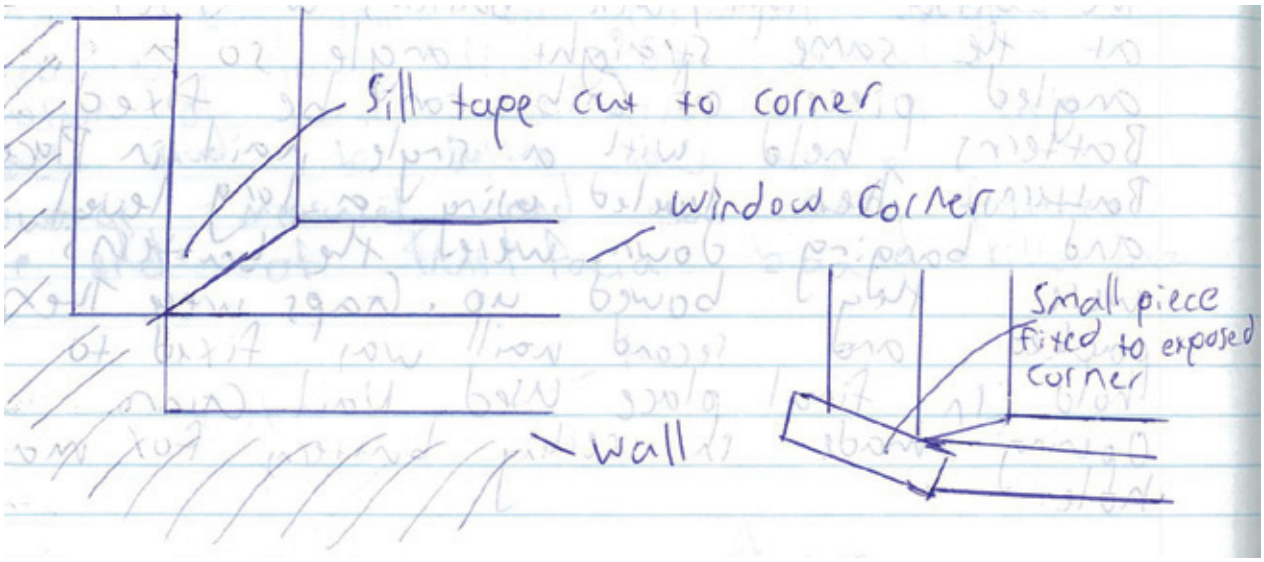

Figure 3.6: ***Two images in an overview-detail relationship***

A final compositional feature that we considered was the relationship between text and image. We followed van Leeuwen's (1991) distinction between images that repeat meaning in the text (or vice versa) and images and text where the information in each is different but complementary. An example of the first is to be found in Figures 3.2 and 3.6, in which both images and text express similar meanings. An example of the second is found in Figure 3.7, where the text concerns work done and costings and the image plans the work and records measurements.

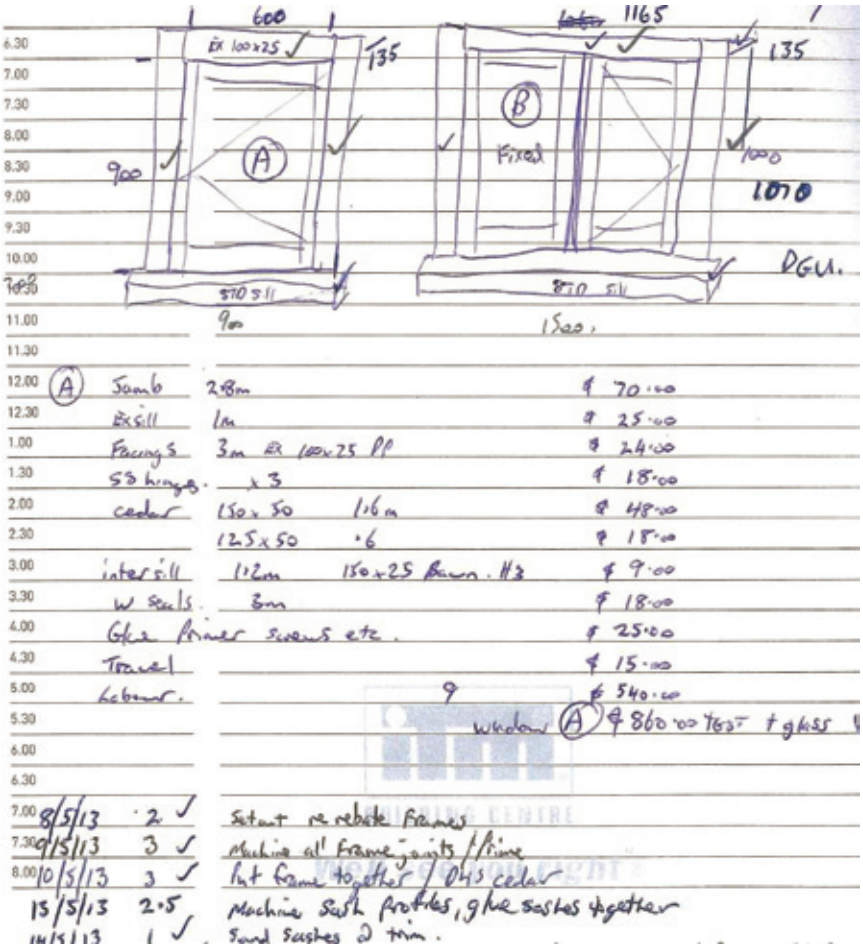

Figure 3.7: *Information in image and text are different but complementary*

3.3 The *Talanoa* research methodology

The Talanoa research methodology, originally described by Vaioleti (2003, 2006), draws on an indigenous Polynesian worldview. This makes it a vital tool in our study in which a bilingual English-Tongan wordlist was developed. In order to do this study, a way of gathering data that is appropriate to our Pacific informants was essential. In the Talanoa approach development of trust between researcher and participant is important, as is appropriateness of behaviour depending on the participants and context, and cultural connectedness between the researcher and participants. Talanoa does not have a preconceived protocol of questions; instead the participants talk about what is important to them, as in an ordinary conversation. This approach takes longer than other interview methods, but the information obtained is likely to lead to richer data and deeper insights, because the research methodology provides a cultural fit for participants. To represent the research process, Vaioleti uses the metaphor of making a *kakala* (garland), which takes place in three parts. The first part is the selection of the leaves and flowers, which corresponds to the selection of participants, and the collecting of the data. In

our study, the *kakala* includes identifying participants in both Tonga and Aotearoa/New Zealand who are experts in trades or trades education and are Tongan. It also involves ensuring that the data is collected in a way that provides the time, space, relationships and atmosphere for the data to emerge. The second part is the weaving of the *kakala*, which involves the integration, synthesis and weaving of the knowledge contributed by participants. In this case, this part includes the checking of the translations of the word lists by the participants, analysing and integrating their interview data and suggestions for the use of this research in their contexts and for their people into the project, and developing our own understandings of this data. The final part is the giving away of the *kakala*, which involves sharing the research to benefit the community. Examples of this sharing include reporting back to participants about the study, publishing articles and reports, developing resources for teaching and learning, and giving talks and seminars as dissemination.

"Talanoa does not have a preconceived protocol of questions; instead the participants talk about what is important to them, as in an ordinary conversation"

3.4 Summary of chapter

In this chapter we have provided a brief introduction to three theoretical frameworks on which we rely in this research project. These include first of all genre theory, the study of groups of texts that serve the same purpose and share the same language features; secondly, we have introduced Kress and van Leeuwen's (1996) 'grammar' of visual design, a framework which allows us to analyse an image such as a photograph, drawing or graph as a way of making visual meaning; and thirdly, we have briefly outlined the Talanoa research methodology, which is rooted in Pacific culture.

Chapter 4
Methodology

Language education research has more frequently used a qualitative approach than a quantitative approach. Because our research draws together a number of closely related studies, drawing on diverse perspectives and undertaken by researchers with different interests and areas of expertise, our study draws on a wide range of methodologies, both qualitative (interviews, observation, manual text analysis) and quantitative (corpus methods and questionnaires). We regard this diversity of perspectives, expertise and methodologies as a strength of our research.

This chapter begins with an outline of the institutional context of our study at an Institute of Technology in New Zealand. It moves on to outline the data collected, including classroom observation, collection of course materials, recording of classroom, workshop and on-site teaching, interviews with tutors and students, and collection of student writing. We outline also our design of our written and spoken corpora, how we processed our data, and finally our methods of data analysis.

4.1 Institutional context

Institutes of Technology and polytechnics in New Zealand offer a range of programmes from Level 1 foundation courses through to New Zealand certificates, degrees and post-graduate study. One of the key areas of focus for many of the Institutes of Technology is vocational education and, within this sphere, trades training. Wellington Institute of Technology delivers a range of vocational and trades programmes, many of which are in the Engineering and Construction Sectors (for example, fabrication or automotive technology and carpentry or plumbing, respectively). Learners have the opportunity, some whilst still at school, to undertake part-time programmes offering pathways into trades training at Levels 1 and 2, where they are introduced to a range of trades. One programmme is the Trades Academy, for learners still at school, and another is Vocational Pathways, which is aimed at learners who may have disengaged from the education system, or who wish to pursue a different vocation, and want to return to study. All of these training pathways lead to the Level 3 programmes that are the focus of this study: carpentry, plumbing, automotive technology and fabrication.

In the New Zealand tertiary context, learners need to demonstrate progress in literacy and numeracy in all programmes from Levels 1 through to 3, which is evidenced through a range of national diagnostic and progress assessments. Therefore, in the four trades programmes, there is a requirement for literacy to be fully embedded in content teaching, that is, integrated throughout the teaching and learning, and at a 'mature' level of embedding (Tertiary Education Commission, 2014).

As outlined above, there is evidence that some learners pursue trades partly because they wish to do practical work, and partly because they do not want to focus on theory and the associated reading and writing (Leach & Zepke, 2010; Lehman, 2005). This can result in some learners beginning study with relatively low levels of literacy or having a resistance to literacy and academic study, possibly consequent on previous educational experiences.

In trades training, much of the teaching is through practical 'hands-on' training. All four programmes in our study, carpentry, plumbing, automotive technology and fabrication, use both theory and practical teaching sessions, working in both workshops and theory classrooms. These trades courses are 34-week full-time programmes delivered over one year. However, what is different about the carpentry programme is that learners build a 3-bedroom house which is then sold commercially. The building of the house underpins the curriculum from the

initial stages of 'setting out' through to the building and the final stages of 'external cladding', when the buildings are signed off and sold. So although this programme, like the others, uses workshops and theory classrooms, the workshops are replaced by the building site, after the initial few weeks. Once learners have completed any of the Level 3 programmes, they can progress onto further training at Level 4. For the carpentry training, this is in the form of an apprenticeship, where learners are apprenticed to builders and are working on commercial building sites and studying part-time for the theory component of their course at the polytechnic, but carrying out all practical training and assessment on the various building sites where they are working. In the area of plumbing, learners go out to industry after the Level 3 programme, and whilst engaged as trainee plumbers, return to the polytechnic to complete intensive block courses. Depending on the engineering pathway that learners wish to pursue, learners can continue with training at the Institute of Technology and undertake Level 4 and 5 courses through to degree and beyond, or become apprentices in automotive technology or fabrication within the industry itself.

"Another difference in carpentry training is the existence of three different streams that students can choose to enter: a Pacific stream, a Māori stream and a regular stream"

Another difference in carpentry training is the existence of three different streams that students can choose to enter: a Pacific stream, a Māori stream and a regular stream. For example, ethnically Pacific students can choose to go into the Pacific Trades stream, which has an ethnically Pacific tutor who is able to provide a culturally and linguistically appropriate environment. Some students in this stream speak English as a second language, and having a bilingual tutor is a benefit to these students. Similarly, Māori students can select to enter the Māori stream, taught by a Māori tutor.

4.2 Data collection

Our study drew largely on corpus and interview data and employed a range of data collection methods, which we outline in this section.

4.2.1 The nature and scope of data collected

Initially, the project aimed to look at six distinct trades, namely carpentry, plumbing, automotive technology, fabrication, electro-technology and bricklaying. In the end, due to a number of constraints (for example bricklaying was not offered at the institution while data collection was taking place), the study was limited to only the first four trades, with some attention also paid to electro-technology (see section 6.3).

Data collection took place from March 2014 until March 2017; however different kinds of data were collected in different phases of the project. Generally speaking, the data collection followed the flow chart depicted in Figure 4.1, with the Gantt chart (Fig. 4.2) providing further detail regarding the timeline of data collection.

installation consortium supply reinforcing bearing
flow frame formwork accordance angle compound fixing foundation
bracing specifications construction voltage

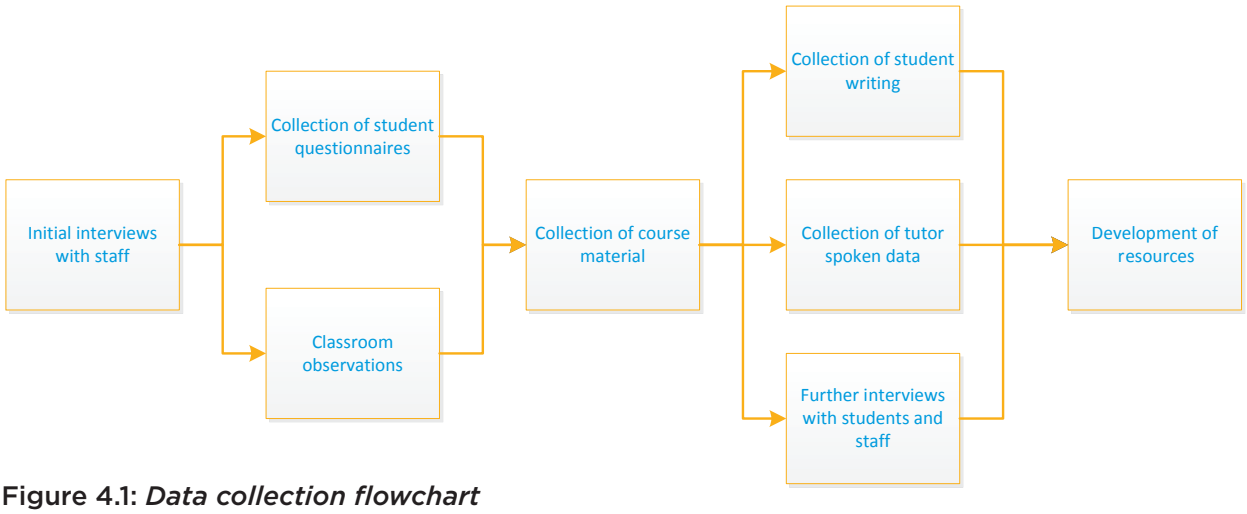

Figure 4.1: ***Data collection flowchart***

Participants

There were four groups of participants in the study. Firstly, there were tutors at Wellington Institute of Technology in the six trades initially selected for study and tutors from five vocational institutions in Tonga. Secondly, there were the Wellington Institute of Technology students of the four trades that were our main focus, as well as three students at Whitireia. On some occasions, Wellington Institute of Technology managers were interviewed regarding teaching philosophy and the mechanics of programme delivery, but these were not substantial contributions to the data. Finally, there were trades professionals in Wellington. The total number of staff participating in the study was 42 and the total number of students who interacted with the project was 58.

Factors affecting the recruitment of staff members included what topics they taught, their availability for observation and whether they were interested in participating in the project or not. Initially, all staff members were approached through heads of school. The initial recruitment of the 23 staff members for the baseline interviews was determined by what parts of the curriculum they taught. It was necessary to gather data from teaching in all parts of each trade curriculum. In automotive trades for example, the range of staff members selected covered auto-electrical, diesel, light auto and panel beating. In carpentry it was different, staff members were selected to represent each of general stream, Māori stream and Pacific trades stream (these are Tertiary Education Commission funding streams that have been used to determine actual classes) as well as those staff members who assessed students doing their apprenticeships (level 4). In plumbing and engineering trades, staff members were initially approached depending on the level that they taught (level 3 or 4). In all cases where more tutors were needed, these were recruited within this framework. Students were recruited depending on the focus of the research question and were always students of the staff members who had previously been recruited. For example, students' diaries that were used for analysis were the students of the staff members who participated in the project in carpentry.

Informed consent was obtained from all participants (staff, students and trades professionals), with ethics approval from Victoria University of Wellington Human Ethics Committee (reference number 19989, see Appendix 12).

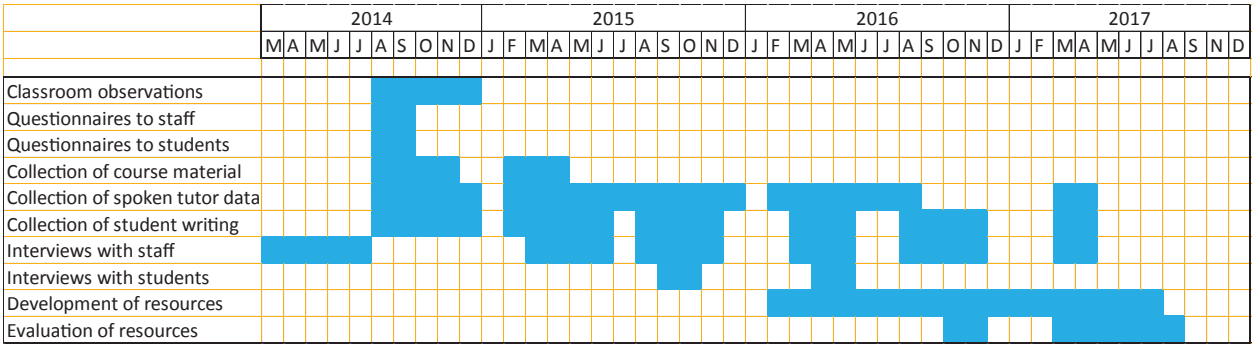

Figure 4.2: ***Gantt chart showing data collection timeline***

Members of the research team who collected the data

Data collection was undertaken by three members of the research team, two of whom were based at Wellington Institute of Technology. The role of one of the team members was as an academic advisor for two of the four trades investigated (carpentry and plumbing), while the second staff member taught in the School of Engineering which had oversight of both the automotive technology as well as fabrication programmes. Towards the end of the data collection, a research assistant helped complete collection of the spoken data. A pre-data collecting meeting was held in order to ensure a common approach to classroom data collection. Similarly, meetings were held to ensure a common approach to interviewing. A third member of the research team, a summer scholar in the summer of 2016/2017, collected data relating to the bilingual word lists part of our project.

4.2.2 Classroom observations

Data collection started with classroom observations and for this purpose, a classroom observation sheet (see Appendix 2) was developed and trialled in the first few classroom observations. Adaptations were made depending on the trade, whether the class was a practical or theory class and what in particular a researcher might be looking for. Classroom observations were initially conducted in five trades. (Bricklaying was omitted due to the fact that it was not offered in the trimester when the data collection started). Table 4.1 shows the number of classroom observations for each trade.

Table 4.1: ***Observed classes***

Trade	Observations
Automotive	5
Carpentry	5
Fabrication	3
Plumbing	2
Electrical	3
Total	**18**

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

While it was the intention of the project to observe five classes in each trade, this proved unnecessary, since for fabrication and plumbing, within two or three observations of tutors, it was possible to get a feel for the environment in which recording of spoken language was to take place. More observations were undertaken in automotive technology because the researcher had an interest in the way tutors used multiple representations of electrical concepts. This was also the reason for the three observations in electrical trades classes. In carpentry, further observations were made to gather more data on the way tutors addressed vocabulary acquisition.

4.2.3 Collecting the written corpus

All written materials that are used in teaching the four trades of carpentry, automotive technology, plumbing and fabrication were collected.

Table 4.2: ***Written resources collected***

Trade	Number of booklets	Corpus size (number of words)
Automotive: Year 1	24	559,000
Automotive: Year 2	23	
Automotive: Panel & Paint	8	
Carpentry: Level 3	7	300,500
Carpentry: Level 4	8	
Fabrication: Level 3 Trimester 1	8	185,500
Fabrication: Level 3 Trimester 2	9	
Plumbing: Level 3 Trimester 1	16	565,500
Plumbing: Level 3 Trimester 2	14	
Plumbing: Level 4	3	
Totals	**120**	**1,610,500**

An overview of the written resource material collected is shown in Table 4.2. This consists of a total of 120 booklets and a corpus size of 1,610,500 words in trades language for separate trades.

4.2.4 Collecting the spoken Corpus

Collection of data for the spoken corpus was very time-consuming. Initially, the intention was to allow tutors to record their own classroom talk over a period and then hand these recorders back to the data collectors. However, this did not work very well. Sometimes, in error, recording was not done or the recorders were misplaced. Sometimes there was difficulty operating the recorders, thus losing data, and, on occasion, inappropriate times to record were selected. This

was especially true in the practical sessions since these were less structured than the formal theory classes. For example, several minutes of a hammer banging constituted one recording.

It was decided that to achieve the data collection, data collectors would be present initially in the classes. This necessitated the employment of an additional research assistant, whose sole job was to ensure that the spoken data was correctly recorded. In the end, 143 hours of useful tutor talk across the four trades was recorded. Table 4.3 shows a breakdown of the recordings for each trade. An attempt was made to record an approximately equal amount of classroom and workshop/on-site teaching. This gave a corpus size of 455,000 words.

Table 4.3: ***Spoken data collected per trade***

Trade	Number of recordings made	Number of hours recorded	Number of Tutors recorded	Corpus size (Number of transcribed words)
Automotive	38	26	9	115,000
Carpentry	37	72	6	108,000
Fabrication	19	26	4	99,000
Plumbing	23	19	3	133,000
Total	**117**	**143**	**22**	**455,000**

4.2.5 Individual Tutor Interview data

Semi-structured interviews were recorded mostly using a standard recorder, but in some cases a smart-pen, which had the advantage of recording both audio data as well as visual data. The smart-pen was particularly useful in capturing tutors' ideas that had a visual component. In addition, the simultaneous capture of notes with audio data made transcription easier. Initially, 23 tutors from all six trades were interviewed individually, the aim being to provide a baseline of the use of language in the trades and also the literacy practices students engaged in. Appendix 3 shows the protocol of questions for a semi-structured interview to identify the literacy practices across the four trades. Later on in the project, tutor interviews were more specific and focused, following up on questions and points of clarification. These follow-up interviews ranged in topic and were different from tutor to tutor. Appendix 4 shows the protocol of questions for an interview with carpentry tutors about linguistic features of the diaries. Appendix 5 shows interview questions for tutors about teaching and learning vocabulary, and Appendix 6 shows interview questions for carpentry students to find out how they learn vocabulary. Table 4.4 shows the breakdown of tutor interviews.

Table 4.4: *Individual interviews with tutors*

Trade	Number of staff interviewed at the start of the project	Number of follow-up interviews
Automotive	6	5
Carpentry	5	10
Fabrication	3	0
Plumbing	3	2
Electrical	3	2
Bricklaying	3	0
Total	**23**	**19**

Interviews on analogies

The methodology used to find out what analogies are used and how they are used in classroom teaching comprised both interviews with tutors about instances in their teaching as well as classroom observation. In all, 23 trades tutors were interviewed to find out what analogies they used. Tutors were asked to explain the analogies they used using a smart-pen, which was then used to make a PDF flash movie of the analogy, thus recording both the visual as well as the audio elements of the explanation. Some tutors were then observed in class to see how they used their analogies in teaching.

Bilingual word list data

In order to prepare a bilingual English-Tongan version of our technical vocabulary word lists, one of the research team (Falakiko Tu'amoheloa) used the Talanoa methodology, which stresses cultural connectedness of researcher and participants, as well as a close relationship of mutual respect, in translating the word lists. Twenty informants, who were Tongan speakers and also knowledgeable about one of the trades, assisted in the translation. Twelve of these were trades professionals in New Zealand, three were trades students in New Zealand, and five were trades instructors at vocational institutions in Tonga.

The researcher began by making a preliminary translation of the 300 most frequent words in each of the four word lists. Although a mother tongue speaker of Tongan, the researcher has no expertise in the trades, so his translations were not always accurate, being those of a layperson without technical knowledge. Expert informants made corrections and additions to the translations of these 300 most frequent words before completing the translation of other sub-lists for each trade. The first 100 words of each of the four bilingual lists is included in Appendix 7.

4.2.6 Data collected by means of tutor workshops

Discussions at group workshops were also useful and the outcomes of these processes were recorded in writing. Several workshops were held with tutors, and data, such as decisions on assessment, the workshopping of assessment criteria, and the design of rubric (see Appendix 13) from these workshops were recorded and collated. While some workshops were audio

recorded, the main output from them was in the form of hard copy teaching and assessment practices as well as observations from the researchers.

4.2.7 Student writing

Trades students are seldom required to produce long pieces of writing; however the Builder's Diary is an example of a lengthy piece of writing. The Builders' Diary is ideally a daily account, over the course of the full year, of what the writer did on the building site. These student journals are used extensively as a teaching and assessment tool in carpentry and due to their success in that trade and subsequent discussions in teaching and learning and as a consequence of this project, student journals were piloted with pre-trade students in automotive technology and in plumbing. In carpentry, 55 such diaries were collected and copied. Informed consent for the use of this data was obtained from all the students involved and in the case of publication of material in academic journals from this set of data, additional specific consent was obtained. The 55 diaries from carpentry were transcribed, yielding a corpus size of 228,900 words which was used for analysis.

The data set employed in our analysis of visual meaning in the Builders' Diary included those diaries (43) that each contained at least 2,000 words. To ensure that each diary was equally represented in our data set, the first 2,000 words from each of the 43 diaries was included, making a total data set of 86,000 words. In total, 1,739 images were included in these 86,000 words. Each image, including photographs and sketches, was coded according to the framework outlined in section 3.2.

4.2.8 Data storage

Data was stored centrally on a common drive located at Victoria University. This was able to be accessed by all researchers, but was controlled by the project research assistant, part of whose role was to organise, collate and process the data in preparation for analysis.

4.2.9 Ethics considerations

In conjunction with a written information sheet, the study was orally explained to all tutors and students who were interviewed, as well as to students who contributed their writing to our study. All data was kept on a password protected drive housed by Victoria University. All data collected was confidential; in reporting our data at conferences and in print, pseudonyms were used instead of names of interviewees and writers. To preserve the identity of our participants, photographs of students' faces were not used in reporting our study. Permission was granted by Wellington Institute of Technology to use printed course material for our analysis. Ethics approval (19989) was obtained from the Human Ethics Committee of Victoria University (see Appendix 12).

4.3 Design of written and spoken corpus

The design of the corpora for this study was specific to the texts collected: written and spoken. Each of the four trades had a written professional corpus which contained all pedagogical materials, including course books, exercise books, industry literature collected at Wellington Institute of Technology, and a spoken corpus which contained recordings of tutor teaching. Carpentry also contains a corpus of student writing, made up of the Builders' Diaries (see section 4.2.7). Table 4.5 shows an overview of the corpora.

Table 4.5: ***Overview of spoken and written trades corpora***

	Trade	Corpora		
Construction trades	Carpentry	Professional writing	Student corpus – Builders' Diaries	Professional spoken
	Plumbing	Professional writing	N/A	Professional spoken
Engineering trades	Automotive technology	Professional writing	N/A	Professional spoken
	Fabrication	Professional writing	N/A	Professional spoken

As well as having the corpora organised by spoken and written mode as in Table 4.5, the corpora for each trade were organised in several different configurations within each trade (using copies) to allow for different levels of analysis. For example, Levels 3 and 4 in the professional writing sections of each trade were kept as separate files in one configuration so that a comparison could be made of these levels at a later date. Another configuration was the use of areas or topics within each trade, such as assembly, materials, tools and welding in fabrication, so that subject-specific technical vocabulary could be tracked. The spoken corpus was maintained in several formats: as individual text files, as single trades, and as a whole corpus of the four trades.

4.4 Data processing and analysis

Data processing used a variety of approaches, because of the wide range of data in this project. In this section, we focus on the various corpus-based data analyses and their relationship to other data analyses, such as interviews. The section begins with the professional writing and speaking corpus analysis, focusing on vocabulary load and the identification of technical or specialised vocabulary in automotive, fabrication, carpentry and plumbing. We then move on to the student writing corpus in carpentry, more specifically the Builders' Diaries, and three sets of analysis: stylistic/grammatical, move, and visual.

4.4.1 Professional writing corpus in the four trades

As mentioned in section 4.2.3, all pedagogical materials, including course books, exercise books, industry literature, etc, were collected and organised into corpora. The principle for selection was that these materials were used in the trades courses at the institution. Most of the materials were collected in electronic form and processed into a form which could be analysed using our research tools. This process involved turning PDFs into word documents and text format, suitable for analysis. All were systematically screened for formatting errors or typos. Once processed, the whole professional writing corpus amounted to over 1,600,000 words. Table 4.2 shows the total running words (or tokens) in each trade in the written corpora.

In order to estimate the vocabulary load of our text corpus and select items for the pedagogical

word lists specific to each trade, the vocabulary in each trade corpus was analysed using Heatley, Nation and Coxhead's (2002) Range Program. Nation's (2006) frequency-based British National Corpus/COCA (BNC COCA) word lists were used to categorise all the words in the corpora up to 25,000 word families. The Range program also contains lists of proper nouns, abbreviations and marginal words (spoken fillers such as um and ah, for example). Any words that were found in the corpora but not in those those lists were identified and categorised so that all words in the corpora were accounted for in the analysis.

Identifying the technical vocabulary of the trades

The process for identifying technical vocabulary from the written corpora involved Nation's British National Corpus and Corpus of Contemporary American English frequency word lists (BNC COCA 25,000, 2016). The first step was to identify and categorise every word in the written corpora for the trades, according to the frequency lists from Nation (2016). Words which did not occur in the frequency lists were kept aside in trades-based lists, while proper nouns, abbreviations, and word family members from the frequency lists were added to Nation's existing lists. New words arising from our corpus but belonging to existing word families in Paul Nation's original lists were added to the relevant word family list (for instance, *unserviceable* and *spacings* were added to baseword list 1 in BNC COCA 25,000 under headwords *service* and *space*, respectively). Similarly, new proper nouns (e.g. *BRANZ*, *Ramset*) and abbreviations (e.g. *NZS*, *VIRM*) were added to the corresponding BNC COCA 25,000 word lists. The resulting trades-oriented BNC COCA corpus includes the updated lists from Paul Nation's BNC COCA 25,000 and the new technical word family lists developed for each of the four trades.

After running the professional writing corpus of each trade through the RangeProgramme of the trades-oriented BNC COCA word lists, frequency principles were applied to the results in order to identify candidates for the compilation of a pedagogical word list for each of the four trades. The selection principles were:

1. Items which occurred more than ten times in the trades corpus from the BNC COCA 25,000 and Nation's supplementary lists were selected.
2. Items with a frequency of 4 or more were selected from the trades BNC COCA based trades lists. The lower threshold for frequency for these words reflected the small size of the corpus.
3. Non-technical words were weeded out through a process informed by double-blind ranking, checking dictionaries, referring to the corpus, using online trade-specific resources.
4. Wellington Institute of Technology tutors took part in decision-making tasks in their specialised trades to determine whether the technical vocabulary we had identified in steps 1-3 above were actually technical (see Appendix 8 for a sample of these decision tasks). The tutors were asked to rate a selection of words as technical or non-technical. In each trade, two to four tutors took part in this decision-making task, rating the technicality of 380 terms on average per tutor. Everyday words with a specific technical meaning were retained (for example, *power, fix, centre, drip, flow,* etc.)
5. The results of Steps 1-4 were combined and pedagogical word lists were developed for each trade.

Multi-word units in carpentry and automotive technology

The trades-based pedagogical word lists contain single technical words, but words occur in the company of other words. Therefore, attention was paid to the use of multi-word units (such as compounds, collocations, and frequent word combinations with a technical flavour) in the trades written corpora. To date, two sets of analysis have been carried out on multi-word units in the written trades corpus. Two main tools were used to identify and count multi-word expressions in the whole carpentry professional writing corpus: N-grams (see Compleat Lexical Tutor, Cobb, n.d.) and WordSmith (Scott, n.d.) and on a sample text in Automotive Engineering (Coxhead, 2017). This analysis was based on the written professional corpora, and began with carpentry and automotive technology. This analysis is ongoing but preliminary findings are reported in section 5.3 below.

4.4.2 Spoken language corpus in the four trades

As mentioned in section 4.2.4 above, MP3 recordings of teacher/student interaction in the classroom, in the workshop or on the building site were collected for each of the trades: these amounted to 26 hours for automotive technology, 19 hours for plumbing, 26 hours for fabrication and 72 hours for carpentry. All these MP3 files were listened to and screened for usability in terms of how they reflected the course content and student/tutor interaction. Irrelevant or inappropriate sections (e.g. private conversations between individuals, segments with background noise only, sections of workshop interaction covered by machine/equipment noises, etc) were discarded. Both theory and practical sessions taught by a range of different tutors on a variety of subject areas were selected for transcription. Due to the large number of recordings available in carpentry, only recordings meeting specific analysis criteria were selected: recordings representing the three different teaching strands (Pasifika, Māori and general) and five different subject areas: Setting out, Framing, Cladding, Insulation, and Linings and Trim (see Table 4.3). Altogether 73 hours of class recordings were selected for transcription for the four trades, averaging just over 18 hours per trade and yielding a total of 455,000 words for our spoken corpus across the four trades.

The selected sections were transcribed by a team of three transcribers. The transcripts were checked against the recordings by one of the researchers in order to eliminate typos and spelling discrepancies and to guarantee consistency in the degree of detail of the transcription work across the trades and across transcribers.

The transcripts were run through the Range Programme of the Trades BNC COCA corpus. For the purposes of vocabulary load analysis, and to find out more about the coverage of the written trades lists over spoken corpora, new words were added to the updated Paul Nation word lists or the trades-specific word lists.

In each trade, the transcripts were grouped together to form broader subject areas with a view to identifying the salient terminology in each subject area. See Table 4.6 for an example of such categorisation for carpentry (i.e. 3 tutors/groups, Theory (Th) vs Practical (P), 5 subject areas corresponding to various stages in the building process).

Table 4.6: *Sessions recorded for each tutor*

Tutor	Setting out		Framing		Insulation		Cladding		Linings and trim	
Tutor 1			Th	P	Th	P			Th	P
Tutor 2			Th		Th	P	Th	P		
Tutor 3	Th	P							Th	P
Beginning ····· **end**										

4.4.3 Student writing corpus in carpentry: Builders' Diaries

As mentioned above, the Builders' Diary is a daily record kept by builders, and, in the case of our study, by trainee carpenters, whose initial training is largely focused on building a house under the guidance of their tutor; after this initial on-campus year they move into the workplace as apprentices. Trainee carpenters note in their diaries when and where the day's work was done, the measurements, materials and tools used, what was done and how it was done. Photographs and sketches also form part of this record.

Diaries were contributed by 55 trainee carpenters: 36 were on-campus students in the first stage of their learning and 19 were apprentices working in industry. The on-campus students belonged to four different groups, each supervised by a different tutor. One of these is a Samoan New Zealander, who teaches the Pacific Trades stream (see section 4.1). Another two tutors work with the apprentices, visiting them on site and providing evening classes. In both modes, students produce a diary to document the work they do.

The 55 manuscripts were copied and/or scanned, then transcribed in detail (verbatim) and turned into electronic format that could be used for subsequent analysis. Questions arising from spelling errors or illegible handwriting were clarified with the help of one of the carpentry tutors. Online tools (like dictionaries) were used to correctly spell technical terms and brand names. The transcription work yielded a total of 228,900 words for our student writing corpus, an average of 4,100 words per diary. The 55 collected manuscripts displayed huge variations in length, ranging from 800 words to 11,000 words. A diary entry is included in Appendix 10.

Tutor interviews about the diaries

Semi-structured interviews with six carpentry tutors were conducted by one of the researchers (a colleague of the tutors) prior to and after the discourse analyses described below. They were audio-recorded and transcribed. This data was then used to identify the purpose and context of the diaries and diary-oriented teaching methods or to discuss the salient features that emerged from our analyses.

Data sets used in analyses of the Builders' Diary

Four analyses were made of the Builders' Diary: a stylistic analysis, a move analysis, and an analysis of expression of visual meaning, and a lexical analysis. Because of the nature of the

analyses, a different data set was used for each analysis. For the stylistic analysis, 2,000-word extracts from 44 diaries was used. For the move analysis, twenty 1,100-word extracts were used. For the analysis of expression of visual meaning, we again used 2,000-word extracts from 43 diaries. This is outlined at greater length below.

Stylistic/grammatical data analysis

The first 2,000 words of each of 44 diaries were used in our analysis of the linguistic/stylistic features of the diaries. Eleven diaries were discarded as their word count was under 2,000 words. Table 4.7 summarises the numbers of diaries for both learning modes (on-campus, novice trainees vs more experienced apprentices working in industry).

Table 4.7: ***Learning mode, tutor, and student numbers***

Learning Mode	Tutor	Student numbers
Apprentice (Level 4)	1	10
	2	1
On campus (Level 3)	3	14
	4	9
	5	8
	6	2
Total		**44**

Both qualitative and quantitative analysis methods were used to identify and then investigate and compare diverse grammatical and stylistic features in the diaries of on-campus students and apprentices. The qualitative analysis of the corpus hinted at a range of different writing styles, operationalised by various language features, namely:

- Full sentences or point form
- Past tense or present tense
- Use of full passives (with *be*)
- Use of elliptic passive (*be* omitted)
- Use of imperative/bare infinitive
- Use of obligation modals (*have/had/has to; need(s) to, must, should, ought*)
- Use of personal pronouns, (*I, we* and *you*)
- Use of named colleagues/classmates/tutors.

For the quantitative analysis, the 88,000-word corpus was converted to text format and run through the Claws7 tagset (UCREL, n.d.) for part-of-speech tagging. Due to some of the diaries

being written in point form rather than narrative form, the correctness of tagging had to be checked manually. WordSmith Tools were then used to search the tagged texts for the pre-determined linguistic features.

Move analysis

To identify what meanings are important in the Builders' Diary, and to identify diaries rated highly proficient by tutors, four carpentry tutors attended a workshop to develop a rubric to assess diary proficiency. A range of criteria emerged from the discussion of the features of ideal diary entries. Based on this discussion, tutors developed the criteria shown in Table 4.8. In addition to information about materials, tools and how the job was done, tutors included visual elements, and language. As a moderation task, the tutors then used the pre-agreed criteria to independently rate four pages (extracts amounting to 600 words on average) from 5 diaries (random selection of pages 10 to 13 in each diary). The tutors discussed their ratings and further fine-tuned their criteria. They then proceeded to grade similar 600-word extracts for all 55 diaries in the corpus.

Table 4.8: *Criteria for assessment of Builders' Diary entries*

CRITERIA
Materials, product information, tools and fixings
What was done. How the job was done. Issues and problems
Drawings, photographs and text
Language level and use of terminology

The top 10 on-campus students' diaries and the top 10 apprentices' diaries, i.e. rated as most proficient by the tutors, were selected for a rhetorical move analysis in the Builders' Diary as a pedagogical genre. Approximately 1,100-word extracts from these 20 diaries (again from page 10 of each diary, amounting to a total of 21,036 words) were used in the analysis. This information is summarised in Table 4.9. The extracts included around 280 daily entries altogether, around 14 per writer. They were written between the third and sixth month of the academic year, which ensured that trainees had had the time to attain some familiarity with the genre. The 20 diary extracts were screened with a view to identifying the most frequent moves.

Table 4.9: *Builders' Diaries analysed in the Move analysis*

	Diaries collected	Diaries analysed	Words analysed
On-campus trainees	36	10	10,481
Apprentices	19	10	10,555
Number of words	230,000		21,036

One of the researchers used insights gained from interviews with the carpentry tutors and from a close reading of the Builders' Diaries to develop a preliminary list of moves and steps. Two researchers then coded 12 diaries independently, simultaneously developing and refining moves and steps. Through discussion, a consensus was reached on a set of 5 moves and on how to divide texts into moves for coding. An additional 8 diaries were then analysed. Once all 20 extracts were coded, rhetorical moves were distinguished as either obligatory (appears in 15 or more texts), or optional (in fewer than 15 texts), each move frequency was calculated and the typical language features of each move were analysed. The two data sets (Level 3 on-campus students vs Level 4 apprentices) were then compared in terms of the number of moves produced and the number of words spent on each particular move.

Visual analysis

2,000-word extracts from 43 Builders' Diaries (33 on-campus trainees vs 10 apprentices) were screened again, this time focusing on the use of photographs and drawings. Again, 11 diaries were discarded as their word count was under 2,000 words; an additional diary was not retained for the analysis as it did not contain any visual images. The diaries that were under 2,000 words in length fell into two types. Firstly, there were those whose authors had written very little. Secondly, there were diaries that covered a short time period and therefore were shorter. Diagrams were not more frequent in either type. All images from each of the 2,000-word extracts (amounting to a total of 1,739 images) were identified and analysed along a set of ideational/representational, interpersonal and compositional parameters: whether they were diagrams/sketches, photographs containing people or photographs with no people; the relationship between the depicted individuals and the viewer; the position of the images on the page; the relationship between visuals within a set of related images; the relationship between the images and the accompanying text.

4.4.4 Analysis of language-related episodes

Sixteen hours of building site and classroom recordings of tutor and learner talk were analysed to identify the extent and nature of instances when tutors or learners drew attention to the specialised words they were using. The unit of analysis used was 'language-related episodes' (LREs) which have been described as 'instances when teachers and learners talk about language, such as grammar or vocabulary, or a feature of the discourse or phonological systems within communication that is primarily concerned with exchanging messages' (Basturkmen & Shackleford, 2015, p.86). These are moments when, during talk, it was focused on meaning and content, either the tutor or learner draw attention to the language they are using, in this case specialised words, either explicitly or implicitly, for example, by giving the meaning of a word or correcting someone's pronunciation. For this study, the LRE began when talk shifted from the building process and instead focused on the specialised words being used. These episodes ended when the talk switched back to the building process. For example:

> Luke[1] [tutor]: … so if you go to take out a wall in certain areas of your house be very careful that one it doesn't compromise the structure of your building and two the weight from your roof isn't ah it's called a load bearing wall as well. So all the bearing of the ah structure is coming down on this wall…

The above example comes from a theory lesson on framing and shows how from discussing the way walls relate to the structure of the building, the talk shifts to explicitly explaining that this type of wall is called a load bearing wall. Once this term has been explained, the talk returns to talking about the structure of the building.

[1] All names are pseudonyms

Once the LREs were identified, they were described in four ways. The first way focused on who drew attention to the vocabulary, whether it was the tutor or the learner. The second way was whether this attention was drawn pre-emptively or reactively. Pre-emptive refers to the tutor or learner 'initiating attention to form even though no actual problem in production has arisen' (Ellis, Basturkmen & Loewen, 2001, p. 414). Often both tutors and learners can be aware of what words may be problematic and draw attention to the words before anyone has tried to use them. In contrast, a reactive LRE occurs when attention is being drawn to the vocabulary in reaction to a real or perceived error when someone uses it. Therefore, a reactive LRE 'arises when learners produce an utterance containing an actual or perceived error, which is then addressed usually by the teacher, but sometimes by another learner' (Ellis et al., 2001, p. 413). The third way LREs were analysed focused on how attention was drawn to the language and included 4 main features: explicit information being given about that word, e.g. its meaning; information about that word being sought through elicitation or questioning; repetition where the incorrect word is repeated but with a correction and finally, by identifying a word as a specialised word to be learnt, but no additional information about that word is sought or given apart from pointing out that it is a specialised word to be learnt. The fourth and final way the LREs were analysed, drawing on Nation (2013), involved identifying what aspect of 'knowing a word' the LRE focused on. These included meaning, pronunciation or no information given (NIG) by the tutor or sought by the students about that vocabulary item in order to facilitate 'knowing a word'.

In addition to identifying the extent and nature of LREs, recordings of semi-structured interviews with both tutors and learners in the carpentry context were reviewed to identify what they had to say about teaching and learning specialised words in this area. And finally, a range of observations were carried out in both the building site and the classroom, to help build the context for the LREs.

4.5 Summary of chapter

In this chapter, we began by introducing the institutional context in which our study took place, and its broader contextualisation within the New Zealand polytechnic sector. We described the participants and the data and outlined our methods of data collection, including observation, written and spoken corpora, interviews, workshops and student writing. We then moved on to describe our data processing and data analysis methods.

Chapter 5 Results and Discussion: Vocabulary in four trades

Technical vocabulary is one of the most noticeable features of text and talk in the trades. At the start of this project, we began by interviewing 23 trades tutors, to get their insights into the literacy demands of learning the trades. Tutors stressed the central role of learning technical vocabulary for students who are learning to 'talk like a builder' or, indeed, to talk like an automotive technician or plumber. Acquiring this technical language is a major step for a learner in becoming a professional trades person and acquiring an authentic trades identity.

Our corpus-based study of trades vocabulary represents a major attempt to describe the lexis of the trades, which is likely to be of use across New Zealand and beyond; the study results in supporting resources for teaching trades language, including trade-specific technical word lists. Our development of a bilingual English-Tongan word list in four trades is important in supporting trades learning of Tongan migrants in New Zealand as well as trades students in Tonga, and also in contributing to developing the technical domain in the Tongan language. Our study of how tutors teach technical vocabulary in the classroom and on-site is important in that it sheds light on the process of embedding literacy teaching into content teaching, a key tenet of the Tertiary Education Strategy for vocational teaching.

In this chapter we include our findings in the area of vocabulary. We begin by considering the vocabulary load of texts that students must read. We then outline the pedagogical trades word lists developed in our study, before moving on to the use of multi-word units in the trades, the development of bilingual Tongan-English word lists through translating the pedagogical trades lists, and an analysis of lexicalisation of technical vocabulary in Tongan. Finally we consider classroom/on-site teaching and learning of vocabulary.

5.1 Vocabulary load of written trades language

The concept of vocabulary load comes from Nation (2006). Calculating the vocabulary load of a text is helpful for determining how many words learners need to know in order to cope with a text (see Nation, 2006; 2013). The more words the learners need to know, the heavier the vocabulary load of the text. Obviously, if learners know all the words in a text, they will be more able to understand it, so the closer we can get to 100% coverage of a text, the better. The figure of 98% is usually quoted in the literature as the percentage of words that learners need to know if they are to comprehend the text (see Nation, 2006). A coverage of 95% suggests that learners would need help with the lexis in a text, whereas 98% coverage and more would suggest that learners might be able to cope with the vocabulary in a text. Vocabulary load analyses have found a vocabulary load of 8,000-9,000 word families[1] plus proper nouns for novels, newspapers, and university-level texts (Nation, 2006). Coxhead, Stevens and Tinkle (2010) found secondary school science texts in New Zealand had vocabulary loads of over 9,000 word families. Nation's (2006; 2013) BNC COCA 25,000 word family lists adapted for our trades study were used to determine the vocabulary load of the trades texts, once all the words in the four written corpora had been classified (see Section 4.4.1 for more on the BNC COCA lists and this process).

To understand the course material (that is to know 98% of the words) in each of the four trades, students would need to understand the 8,000 most frequent English word families. They would also need to understand the proper nouns, the abbreviations, the technical words identified in our pedagogical word lists for their trade, the word compounds, and marginal words. A lower vocabulary load at 95% was also calculated because it represents the level at which learners could read their trades texts if they had support (Laufer & Ravenhorst-Kalovski, 2010). To reach 95% coverage, learners would need to know the 5,000 most frequent word families in

[1] A word family is the base form of a word (e.g. *learn; cover*) plus its inflected forms (-s, -ed, -ing) (for example *learned, covers*) and forms derived by use of affixes (-able, -er, -ish, -less, -ly, -ness, -th, -y, non-, un-, -al, -ation, -ess, -ful, -ism, -ist, -ity, -ize/-ise, -ment, in-) (for example *learner, unlearn, coverage, recoverable*) (Hirsh & Nation, 1992)

English + proper nouns, abbreviations, the technical words identified in our pedagogical word lists for their trade, compounds, and marginal words needed for each trade. In other words, reaching 98% requires 8,000 word families while reaching 95% requires 5,000 word families, plus in both cases both Nation's and the trades supplementary word lists. Both these figures represent a large number of words, which means trades students need large vocabularies to cope with the reading in their area of study. The pedagogical word lists developed in this project are helpful because they identify technical vocabulary which all these learners will encounter often in their texts and in classes (see 6.2). For more on vocabulary load, see Coxhead et al. (2016) and Coxhead and Demecheleer (under review). The vocabulary load of the spoken trades texts suggests that learners need a much smaller vocabulary to understand these texts, but this analysis needs further work for confirmation.

The significance of this for learners is that in order for them to be able to learn the content, they will need to understand the words on the page and thus need support in being able to learn the key vocabulary. Identifying which are the most frequent words, and potentially the most useful, could help to focus learners' attention on the words that will be most useful in terms of communicating and understanding in this context.

"To understand the course material (that is to know 98% of the words) in each of the four trades, students would need to understand the 8,000 most frequent English word families"

5.2 Pedagogical word lists of the trades

Pedagogical word lists were developed for each of the trades, based on the written corpora for each trade. These technical word lists were made available in two formats. One format was a list with common word families (which means the headword in each family is listed) and the other was a list of the most common word types in each family as identified in our corpus. *Types* as a term refers to individual words, as opposed to word families. For example, the word *fixings* is a type. The trades word lists are divided by frequency into 100-word sublists, meaning that the most frequent words are in the first sublist of 100 words for each trade, and so on. The most frequent words in English are the most important words for any learner (Nation, 2013), and other technical word lists have also been listed by frequency, such as Coxhead's (2000) Academic Word List. Alongside the pedagogical word lists for each trade, we developed lists of common abbreviations (and their meanings) for all four trades and proper nouns (for carpentry only). Proper nouns for the three other trades were incorporated into the pedagogical word lists because there were not very many. In carpentry, however, there were 29 proper nouns so we made them into a separate list. The total word lists for the different trades are summarised in Table 5.1 over the page.

Table 5.1: ***Trades-based pedagogical word lists and abbreviations***

Trade	Word families	Abbreviations	Proper nouns
Automotive	1,225	96	Incorporated
Carpentry	1,427	101	29 (separate list)
Fabrication	1,044	55	Incorporated
Plumbing	1,362	73	Incorporated

We then developed a list of the most common type(s) for each of the word families so that we could focus on those most frequent words in the resources that were developed as part of the project.

Not every word in a word family is a technical word in a trade: *flashing* and *flashings* are listed in the carpentry technical word list, but the word family member *flash* (incidentally the headword of that family) is not in the list because it is not a technical word (or type) in carpentry. Table 5.2 shows the top ten types in each pedagogical word list. Note that in carpentry, *requirement* is the most frequent word but the word family member *requirements* is also very frequent. This relationship between the words is why *requirement(s)* is listed. The same pattern can be seen in *building(s)* in plumbing.

Table 5.2: ***Top ten words in the four pedagogical technical word lists of the trades***

Carpentry	Plumbing	Automotive technology	Fabrication
requirement(s)	pipe	check	weld
figure	drain	engine	work
building	building(s)	test	figure
wall	require(d)/ requirement	volt	cut
timber	gas	figure	tool
roof	heat	pressure	material
concrete	installation/ install(ed)	battery	machine
installation	work	vehicle	source
construction	pressure	fuel	steel
fixing	valve	circuit	centre

We deliberately listed the words by frequency and not by alphabet. If the top ten words of the carpentry list were listed by alphabet, that list would look like this: *activity, adhesive, applied, area, batten(s), beam, bear, block, board,* and *bracing*. Compare this list with the carpentry top ten in Table 5.2, starting with *requirement(s)*. The alphabetical list does not show which words are the most frequent. Ideally, a searchable online list would help learners and teachers with guiding their decisions on what technical vocabulary to focus on for each trade and subject within the trade.

We found that the carpentry and automotive technology pedagogical word lists covered over 30% of their respective written corpora. These findings are important, because Chung and Nation (2003) similarly found that over 30% of an anatomy text was technical. Our findings dovetail well with their findings, even though we used a different methodology in our study. The coverage over spoken trades texts by these technical word lists, by contrast, is under 10%, which is important because we began our analysis with written trades texts rather than spoken. This finding suggests that technical vocabulary occurs more frequently in written texts than in spoken texts, which has implications for students who are learning mostly through spoken means in their trades studies.

A feature of these technical trades word lists is that they include general words in English with technical meanings as well as more traditionally technical words. For example, *roof* was identified as a technical word through our analysis, but the general meaning of this word is probably well known by most speakers of English as a first or second language but not seen as technical. Another example of a general word having a technical meaning is *line*, as in *to line a wall* in carpentry. We think this is an important aspect of technical vocabulary, as learners may need help understanding that a word that they know well in general English has a technical meaning in the trades. It is also important to note that these technical words often occur with other words in the trades, and this relationship is discussed in the section on multi-word units below.

Part of the checking of the technicality of the trades lists involves using our trades-adapted version of Heatley, Nation and Coxhead's (2002) Range Programme to investigate the occurrence and frequency of the trades vocabulary in other corpora. We used a corpus of written academic English and a corpus of fiction for this analysis. The automotive list has coverage of under 5% of an academic written corpus of three million running words used in Coxhead's (2000) research into academic vocabulary and just over 2% in a three million word corpus of fiction (also from Coxhead, 2000). So, in comparison with the more than 30% coverage of the trades lists over their respective trades, we can see that the coverage of other kinds of texts is much lower (5% and 2%). These figures suggest that the pedagogical trades lists contain mostly trades-specific vocabulary. Further analysis is needed to investigate the nature of the words which occur in the trades, academic writing and fiction corpora. There is no doubt that some of these words will be general high frequency items, such as *the*, *a*, and *with*, but some items will also be general words in English which also have technical meanings in the trades.

The trades-based pedagogical word lists, together with tips and strategies, were made available to the tutors for feedback. See Appendix 9 for the first 100 words in each technical wordlist. See Coxhead, Demecheleer and McLaughlin (2016) for the identification of technical vocabulary in carpentry and Coxhead and Demecheleer (under review) for plumbing. Work is now in progress in building glossaries based on our carpentry pedagogical lists to be included in the

new resources being developed by Wellington Institute of Technology staff. For carpentry more specifically, the most frequent types have been identified for each of 23 subject areas that are covered in the portfolios in development at Wellington Institute of Technology. Examples of subject areas are: *Levelling Contours, Wall Framing, Cavity battens, Insulation, Interior Trims,* and *Hand Tools.*

5.3 Multi-word units and the trades

Prior research into multi-word units has focused mostly on the most frequent general word sequences in English in a range of contexts, as can be seen in the work of Biber (2006) in university contexts, for example. In our study, the focus was on developing an understanding of the amount and kinds of technical multi-word units in the trades. There are examples of multi-word unit research in academic contexts (Biber, 2006) but little of this research has focused on trades or technical word sequences. Using a corpus-based approach, we trialled a new methodology for finding technical multi-word units and identified over 4,000 multi-word units in carpentry as a pilot study. To develop a list of frequent multi-word units, we selected items which occurred more than three times in the carpentry corpus. If a word was related to another unit in the list, for example the plural form of the noun in a frequent word string (for example *right angle/right angles*), it was kept. Many of these are two-word units or compounds which are very frequently used in the carpentry pedagogical resources (e.g. *floor joists, load bearing walls, roof cladding, framing members*). The ten most common word strings, occurring over 100 times in our 300,000-word written corpus, which we identified in this pilot study were *form work, plaster board, health and safety, building consent, NZS 3604, building code, cross section, GIB plasterboard, GIB site guide*, and *on-site*. Related forms of frequent word strings, such as inflected forms (e.g. *adjustable wrenches* and *base coats*) or alternative spellings (e.g. *bevel back weatherboards* or *bevel-backed weatherboards*) were also added to the base form, even though the frequency of these related forms may have been lower than 3.

"The ten most common word strings, occurring over 100 times in our 300,000-word written corpus, which we identified in this pilot study were form work, plaster board, health and safety, building consent, NZS 3604, building code, cross section, GIB plasterboard, GIB site guide, and on site"

We also looked at automotive technology and multi-word units (Coxhead, 2017). Using a text from the corpus on diesel engines and looking for 2-7 word strings, we found 1029 word strings, mostly made up of 2-3 core patterns. In this small text (9,500 words), we decided to set the frequency at two or more occurrences, as part of the trial. Out of the 1029 strings, 18 multi-word units occurred 100 times or more in the whole written automotive technology corpus. The most frequent word sequences from the text on diesel engines, occurring over 200 times in the corpus, are *cooling system, control valve, fuel system*, and *cylinder head*. We note that some words occur frequently in sequences with others. An example is fuel in *fuel system, fuel filter,*

fuel injector and *fuel pressure* all occur more than 100 times in the written corpus. Another example is *pressure*, as in *high pressure, low pressure, fuel pressure, air pressure, pressure test, atmospheric pressure* and *pressure sensor*, to name just a few. It is difficult to organise this kind of data so that it is presented clearly and able to be dealt with by learners and teachers in classrooms (Byrd & Coxhead, 2010). For our trades study, a first attempt is being made at organising these multi-word units into families, in collaboration with Wellington Institute of Technology staff. Again, a pilot study in carpentry has focused on identifying the most frequent word strings in a range of different topics. These, together with the most frequent types for each of these topics, will be instrumental in developing the glossaries for each of the 23 portfolios under development at Wellington Institute of Technology.

5.4 Bilingual vocabulary lists

We report on the study in this section in greater detail in Coxhead, Parkinson and Tu'amoheloa, (in press). As we discuss above, as many as 25% of students studying carpentry are of Pacific ethnicity, and census data (Statistics New Zealand, 2014) indicates that we can expect that up to one-third of these to have been born outside of New Zealand, and thus likely to be learning in English as a second language. For such students an element of bilingual education is likely to be of value. In this section we describe the English-Tongan word lists that were developed as part of our study.

5.4.1 Insights from interviews with informants

Our study drew on insights from fifteen New Zealand-based informants, who were all migrants to New Zealand from Tonga. Interestingly, they reported varied experiences of learning trades language in English. Some reported that they had started working in their trade in New Zealand after prior trades training in Tonga. Many noted an early struggle with both everyday English and the technical language of the trade. Other New Zealand-based informants reported that they had worked in their trade in New Zealand first before doing formal training. Despite their prior industry experience, they still struggled with technical terms during their first year in Level 3 training. Since all had experienced some level of difficulty with English during their years of training, they welcomed the translation of the technical terms, believing that this work would help Tongan students studying these trades in New Zealand. They also pointed out the potential of the translated lists to support trades learning in Tonga.

Our study also drew on the insights of five Tonga-based informants, who were all trades instructors. They expressed the opinion that the bilingual word lists would be extremely valuable in their teaching. They reported that the five Tongan vocational institutions that they teach at are English medium institutions, but that Tongan is used in the classroom as well as English because not all students are fully proficient in English. Their institutions enrol students who have completed form 4 (equivalent of New Zealand year 10), although some of their students have completed the equivalent of year 13.

5.4.2 Tongan translation of vocabulary lists

Our analysis of interview-based data about vocabulary suggested that the translated words fell into a number of categories. These included:

- Words with a Tongan equivalent (Table 5.3)
- Items that have adopted the English term and use it with a Tongan spelling (Table 5.4)
- Items for which there is no word in Tongan; a meaning needs to be given for these (Table 5.6)

Table 5.3 shows words for which there is a Tongan equivalent. Many of these are words to name objects that existed in Tongan before contact with English.

Table 5.3: ***Words which have a Tongan equivalent***

Trade	English Vocabulary	Tongan translation
Automotive	correct	*tonu*
	engine	*misini*
Carpentry	building	*langa*
	wall	*holisi*
Fabrication	welding	*kasa*
	work	*ngāue*
Plumbing	installation/install(ed)	*fokotu'u*
	drain	*fakatafe*

Table 5.4 shows words that are borrowed from English that have a Tongan spelling and pronunciation. Examples are valve = *vaolo* and steel = *sitila*. Most are words to name objects that have come into existence with the introduction of modern technology.

Table 5.4: ***Words which have 'Tonganised' the English term***

Trade	English Vocabulary	Tongan translation
Automotive	valve	*vaolo*
	unit	*'iuniti*
Carpentry	material	*matiliolo*
	steel	*sitila*
Fabrication	point	*poini*
	table	*tepile*
Plumbing	gas	*kasa*
	seal	*sila'i*

Table 5.5 shows words for which there is no Tongan word. A meaning needs to be provided for these in Tongan in order to translate them. This is one of the difficulties in translating vocabulary noted by M. Baker (2011). As Table 5.5 shows, most of these are words to name objects and concepts that were introduced along with modern technology.

Table 5.5: ***Words that need to be explained, as there is no Tongan word***

Trade	English Vocabulary	Tongan translation
Automotive	lead	*tataki pe pulu fakamamafa*
	output	*ola 'o ha ngāue pe koloa kuo ngaohi*
Carpentry	activity	*ngāue ke fakahoko*
	joist(s)	*ngaahi fo'i ha'i*
Fabrication	arc	*konga 'o ha fo'i ngaofe pe siakale*
	component(s)	*kongokonga 'o ha me'a*
Plumbing	gasfitting	*ngaue kotoa ki he ngaahi paipa kasa*
	ventilation	*Fehu'aki 'a e 'ea 'i he fale*

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

As we might expect, there are fewer technical words that do not have a Tongan equivalent (Table 5.5) amongst the high frequency English sub-lists; if a technical word is used very frequently in the Wellington Institute of Technology course material, it is likely to have a Tongan equivalent. On the other hand, English technical words that do not have a Tongan equivalent appear more and more frequently in the low frequency sub-lists; so if a word is used much less frequently in the Wellington Institute of Technology course materials, there is less likely to be a Tongan equivalent for that word. As an example, only 22 of the words in the 100 most frequent English technical words in our automotive technology word list had no equivalent in Tongan (see Table 5.6). A further 11 could be expressed in two words and 67 could be expressed as a single word. Amongst the 100 least frequent words in our automotive technology word list, as many as 81 had no equivalent in Tongan, nine could be expressed using two words and as few as 10 could be expressed using a single word.

Table 5.6: ***Expression of English technical words in Tongan: The 100 most frequent and 100 least frequent technical words in the automotive technology word list***

Expressed in Tongan as	Sub-list 1: the 100 most frequent technical words	Sub-list 12: the 100 least frequent technical words
one word	67	10
two words	11	9
Fabrication	22	81

This bilingual wordlist is important for several reasons. Firstly, by recognising Pasifika languages and giving them a place in the classroom, it enhances recognition of Pasifika learners, and makes trades classrooms more welcoming of them. Secondly, it provides a scaffold for learning trades vocabulary for Tongan learners. Another important significance of this work is that, in being the first description of trades language in Tongan, it increases the technical domain of the Tongan language, thus enhancing its long term vitality.

5.5 Vocabulary learning in carpentry

This section describes a case study of vocabulary learning and teaching in the trades (see McLaughlin & Parkinson, under review, for a more detailed account of this research). In it, we focus on how tutors support the acquisition of vocabulary in carpentry training. As discussed in section 3.1, carpentry learning follows an apprenticeship approach where learners learn by doing and from a more experienced other; this approach seems to be reflected in how the language of carpentry, specifically, technical words, are learned. We drew on three sources of data to identify how this process occurs: semi-structured interviews with learners, semi-structured interviews with tutors, and analysis of 16.5 hours of recorded tutor talk and tutor-learner interaction. Classroom observations were also undertaken to build understanding of the context.

What do the learners say?

According to the learners, one of the key ways they learn the specialised words is through doing practical work:

> Working with them and use the word more...once we started working on the *soffit* we became more familiar with what it is when we are working with it and referring to it all of the time...working with it and doing the jobs around the word (carpentry learner, 2016).

> Pick it up as you go...it wasn't until I performed the task that I learnt the word...I think the practical is the way to learn the word (carpentry learner, 2016).

These quotes demonstrate the 'learning through practice' approach that is applied to learning carpentry vocabulary words in this context. The next three quotes illustrate an additional way the specialised words are learnt, through tutor talk:

> I told him to elaborate on it, *fascia board, soffit* (hard ones) asked him to explain... always asked in class, always asked questions (carpentry learner, 2016).

> Ask Luke, Luke [his tutor] would explain the word before we started using it (carpentry learner, 2016).

> Try and memorise it...ask Luke...ask some of the boys (carpentry learner, 2016).

These quotes were in response to the question: What do you do when you hear a new word? There is a strong emphasis on the talk and asking for explanations from both their tutors and peers.

Additional ways learners reported learning new words included repetition, memorisation and writing the words in their Builders' Diary (see Chapter 6) including developing their own glossaries. In response to the question 'Do you use glossaries?', of the nine learners interviewed eight reported that they used the glossaries provided and felt they were useful for learning new words and one learner said 'I love the glossaries I use them a lot to learn them'.

Therefore, it appears that in addition to doing the practical work and listening to tutor and peer talk, and using both tutors and peers as a source of clarification, many of the learners also use glossaries to aid their vocabulary learning.

What do the tutors say?

Similar findings were highlighted in discussions with tutors. When asked the two questions 'How do you teach these words?', and 'What do you think are the most effective ways for teaching your learners new words?', one of the main responses that the three tutors gave related to 'using the word':

> Mark: We just use it, always use, demonstrate, show...most important is what it is used for; collocations: boundary joist, boundary line.

> Ben: use it bit of a game...deliberately use them and put them in so they listen out for them... best way to teach learners is use them...seeing...hearing...experiencing... don't answer learners until they use the correct words. What are you talking about? What does it do? What is it for? What is it called? You mean a *purlin*?

> Luke: Use it, use it from the get go explain what they will do and make when they pose a question elicit the correct term...when they start using these words we can have conversations like builders...

All three tutors echo the learners' comments around using the words and the last two quotes contain reference to drawing attention to the language through tutor talk through deliberately using them and eliciting them. In addition to focus on use, tutors also described a range of strategies they used including writing words on the boards, putting words in context, giving learners sentences, breaking words into parts, using synonyms and focusing on pronunciation.

Analysis of language-related episodes (LREs)

In the 16.5 hours of recorded tutor talk and tutor-learner interaction, attention was drawn to the language being used in a variety of ways. One of the most frequent ways was through tutors and learners drawing attention to a word before any issue with using that word arose. For tutors, this was mainly through giving information, for example, linking meaning to form.

For learners it was mainly through asking for information about a word:

> L: If you only do two points, foresight and is the other one called an intermediate or?
>
> T: If you do, you always start with a backsight then if you do two points they are called intermediate and if it's your last point you call it your foresight 'cause that tells you it's finished.
>
> L: Ok, it's finished.
>
> T: Yeah, yeah. Ok at least you're getting the terminology.

The above quote is interesting because the tutor explicitly refers to the learner 'getting the terminology'. Tutors and learners also drew attention to the specialised words reactively, after a word was used incorrectly and the example below shows a tutor correcting a pronunciation error:

> T: Doubling stud
>
> L: Dumbling studs
>
> T: Doubling, doubling studs
>
> L: Doubling, gibbing

In the above example the tutor reacts to the learners' mispronunciation 'dumbling' by repeating the correct form 'doubling' which the learner then uses.

As well as both tutors and learners drawing attention to aspects of the words before or after words were used, focusing on areas such as meaning and pronunciation through either giving or eliciting information about those items, tutors also drew attention to specialised words as items to be learned, without giving or seeking any further information about those words:

> T: ok so it says here you will need to know the meaning of the following terms, beams, blocking, plates, double studs, doubling studs ah, dwangs, nogs, jack studs, lintels, posts, sills so on and so forth. Um we'll go through a lot of these just like how we did our floor framing um the same thing again ok … It's a lot easier if we go and just do it and we'll sorta fiddle our way through it as opposed to boring you for the next three hours 'bout stuff that you don't know.

What is particularly interesting about the above extract is that after the tutors have drawn attention to the list of specialised words that need to be learned, the tutor then refers to how

it is easier to learn the words through doing the practical work 'it's a lot easier if we go and just do it'. This seems to mirror what tutors and learners say about learning the words through the practical work and also what Lave and Wenger say (1991) that language is part of practice, here the practice of carpentry and it is through this practice of the trade that the specialised words are learned. The significance for both tutors and learners in this context is that it highlights ways tutors and learners approach the acquisition of the specialised terms. By understanding what tutors are already doing, and what might work in such a training context, strategies and approaches can be developed, drawing on the research here, to further support the embedding of language in this context, and help learners understand and use, carpentry specific words.

5.6 Summary of the chapter

This chapter describes a valuable contribution to what is known about technical vocabulary and how it is taught in trades classrooms. Section 5.1 describes the vocabulary load of the technical language of trades texts, reporting how big a vocabulary a trades student needs in order to read their course material. Section 5.2 discusses the technical word lists which we have developed, and section 5.3 points the way forward to research into technical multiword units. In section 5.4 we describe the development of bilingual English-Tongan word lists, valuable for Tongan trades' students in both New Zealand and Tonga. Finally, section 5.5 documents how literacy development is embedded in trades teaching, an important contribution to a teaching approach mandated by the Tertiary Education Commission (Ministry of Education, 2009, 2012). Chapter 8 contains recommendations for pedagogy based on the findings of this chapter and suggestions for future research.

Chapter 6 Discourse features of language in the trades - Results and Discussion

The description of the vocabulary of the four trades in our study, which the previous chapter has outlined, is an important step in recognising the complexity of trades language, and the size of the vocabulary that a student needs in order to read trades texts. In addition to providing this description, the previous chapter also provided the results of an analysis of how trades tutors mediate understanding and use of the new technical register that students need to acquire. However, in addition to learning the vocabulary of the technical language of their trade, a trades student must also learn to put this new technical language together in coherent pieces of discourse.

Moving on from this description of the vocabulary of technical trades language and account of strategies to teach this vocabulary, therefore, in this chapter we are concerned with larger stretches of discourse than in the previous chapter. We approach this from three perspectives: student writing, classroom teaching, and use of visual meaning in both course material and student writing. Firstly, we provide evidence that students have acquired the technical language. We draw this evidence from the writing in students' Builders' Diaries (section 6.2). In addition, in this chapter, we provide a further account of an important strategy in teaching concepts rather than vocabulary: the use of analogies in classroom teaching (6.3). We also analyse how technical trades discourse relies on visual as well as written and spoken expression of meaning, and how this is used in student writing (6.4.2) and in course materials (6.4.1). Before moving on to look at language use in these three contexts, we begin by reporting on our initial survey of trades literacy practices which informed many of the studies reported in this chapter and the previous one.

"We interviewed six automotive technology tutors, five carpentry tutors, three fabrication tutors and three plumbing tutors. These initial interviews were extremely useful in pointing to directions for investigation which we followed in the rest of the project."

6.1 Initial survey of the literacy practices of trades education

We began the project with an initial scoping exercise to establish what the literacy demands of study in the four trades are. We did this not only by considering the requirements as laid out in Tertiary Education Commission documents (Ministry of Education, 2009, 2012) (see section 2.1), but also by initial analysis of course material, and by talking to tutors to gain their insights. We interviewed six automotive technology tutors, five carpentry tutors, three fabrication tutors and three plumbing tutors. These initial interviews were extremely useful in pointing to directions for investigation which we followed in the rest of the project. We report in greater detail on the findings of these interviews in Parkinson and Mackay (2016). Appendix 3 shows the protocol of questions for a semi-structured interview to identify the literacy practices across the four trades.

Tutors reported that students must learn technical vocabulary as well as words that are everyday words that have a specialised technical meaning. An example is apparently everyday words like 'fix' which are used in a specialised way by trades professionals, and the names of tools and materials (see section 5.2).

Tutors reported that qualified trades people need to be able to talk 'trades talk', a technical register understood by professionals, as well as to be able to talk to clients and professionals outside their trades, such as architects and engineers. Tutors described how the process of learning 'trades talk' involved engaging in this talk with tutors and classmates (see section 5.5), being able to correctly talk about, for example, 'the size of the nails, the size of the timber, the grade of the timber, the treatment of the timber', etc.

Interestingly, several automotive technology tutors referred to how their students employ informal talk about cars to integrate what they already know about cars with what they have been learning in formal study at the polytechnic. Tutors encourage such informal talk as they see it as encouraging learning of talk-specific language and also as encouraging development of a trades-specific identity. This is an as yet unexplored avenue which we intend to pursue in future research.

To support understanding of difficult technical concepts, tutors use a range of analogies in their talk in classroom/workshop teaching. We report on our investigation of these in section 6.3.

Besides talk, tutors noted that reading is important in trades learning (see section 6.3). Given that we collected 1.6 million words of trades course material (see Table 4.2), it is clear that students are expected to read extensively in their study. We found that the texts students read include pedagogical texts (course books, worksheets, notes, and textbooks), technical texts (manufacturers' specifications and service manuals), as well as legal texts such as legal regulations and New Zealand Building Standards.

Trades literacy involves being able to read texts that contain both the textual and visual modes. Course material, service manuals and manufacturers' specifications contain a wide range of visual elements, ranging from photographs and drawings, to tables, graphs and mathematical equations. We enlarge on this aspect of the study in section 6.4.1.

Trades students do less writing than they do reading. Carpentry students are unusual in producing a lengthy piece of writing, the Builders' Diary. We report on our investigations of this diary in sections 6.2 and 6.4.2. Students also record practical work in the other three trades, and write assignments and reports describing processes and providing explanations.

6.2 The Builders' Diary

This section reports on two studies of student writing. This research is important because it provides evidence of student use of and thus learning of trades language. Because it is an extensive piece of writing, we used the Builders' Diary as a case study. We investigated firstly the stylistic/grammatical features that students use in writing the Builders' Diary (section 6.2.1), and secondly the meanings they include in the Builders' Diary (6.2.2). We report in greater detail on the first of these studies in Parkinson et al. (2017) and on the second in Parkinson et al. (in press).

6.2.1 The stylistic/grammatical analysis

This section reports on interviews with our expert informants, carpentry tutors, before going on to report on our findings from our qualitative investigation, and findings from our quantitative investigation. We report the implications of the study in section 8.2.7.

Interviews with carpentry tutors

Interviews with carpentry tutors helped identify writers' purpose in the Builder's Diary and highlighted the differences in purpose between the Builder's Diary as a professional genre and as a pedagogical genre. The six purposes in Table 6.1 were mentioned by the tutors (see Parkinson et al., 2017 for a more in-depth discussion). Some of the purposes are relevant to professional builders, while others are relevant to students:

Table 6.1: ***Purpose in the Builders' Diary***

Relevant to professional builders	• Giving evidence in court in the case of a dispute • A record of hours worked for billing
Relevant to students	• Acquiring the habit of writing the Diary: as one tutor said, 'Teach them now and they'll have to do it in their working lives'. • Keeping a record for long-term future reference: 'in 5 or 10 years' time they can go back to that diary and say "how did I do it then?"' • Job prospects: 'it gives an employer a better idea of what that student has been up to'. • Student assessment.

Tutors reported that they explain to students these purposes of the Builders' Diary. Students are told that the main purpose of the diaries is for the assessment of unit standards through the accumulation of evidence of work done. Moreover, the Builders' Diary is represented to students as a learning tool for the students to record information and processes etc, in order to develop a portfolio of work completed for when they are looking for a job and also to develop their literacy and use of building and construction language.

Qualitative analysis of Builders' Diaries

In the light of the insights gained from tutor interviews, we examined the 44 builders' diaries in the corpus qualitatively. This illuminated not only differences in the amount and frequency of the trainees' writing, but also large variations in the language features used.

Firstly, more than half of the writers used full sentences rather than point form. Of those that used full sentences, almost all used the past rather than the present tense. Most of those using full sentences also used personal pronouns. Of those who used point form, some employed imperatives/bare infinitives, while others used elliptic passives (*be* omitted).

The three excerpts below illustrate the range of styles, from most narrative to most concise and telegraphic. Excerpt 1 was written by a Level 3 on-campus student. The writer uses the personal pronouns *I* and *we*, and mentions teammates by name. He writes in full sentences using the past tense and uses obligation modals (*have to, had to*). His account is detailed,

providing information that would be useful if he did this task again, one of the purposes of the diary mentioned by the tutors. A photograph of the house, with two students working on it accompanied Excerpt 1, adding to the personal element of the writing.

Excerpt 6.1: ***The personal Builders' Diary***

> **Ken** and I continued to apply the plywood across the wall, as the ply covers the window, I *had to* use the jigsaw to cut a space to be used for a window. *Making sure* I cut 5 cm in so there is enough for the router to finish up with a clean finished cut. We started doing a new wall leaving the whole board in one piece so **Dave** can come around with the router so we don't *have to* use the jigsaw.

Excerpt 2, written by a Level 4 student, is an impersonal text which does not use personal pronouns or teammates' names. Written in point form it uses elliptic passives (*shaved back, moved*). Excerpt 2 was accompanied by a photograph showing the work described, with no people in it.

Excerpt 6.2: ***The impersonal Builders' Diary (from Parkinson et al., 2017, p. 35)***

> **Digged out** footing for front half of garage and for block retaining wall.
>
> Bank shaved back on slight angle to stop slipping.
>
> Pipe and services all moved out of way.

The author of Excerpt 3, also at Level 4, was, according to his tutor, an experienced carpenter. This diary included costing of materials and labour (see Figure 3.8), facilitating the purpose of billing customers, and indicating the writer's professional expertise. His diary was very concise, consisting of lists of tasks undertaken, costs of materials and labour, and detailed sketches. It uses imperatives/infinitives (*Set out, Machine, Prime,* and *Glue*) and avoids personal pronouns. A detailed sketch (Fig. 3.8) accompanied Excerpt 3 showing dimensions of the work undertaken.

Excerpt 6.3: ***The professional Builders' Diary (from Parkinson et al., 2017, p. 36)***

8/5/13	2	**Set out** re rebate frames
9/5/13	3	**Machine** all frame joints/**Prime**
10/5/13	3	**Put** frame together/DHS cedar
13/5/13	2.5	**Machine** sash profiles, **glue** sashes together

In Excerpts 1, 2 and 3, we see development from a personal narrative, detailed account in Excerpt 1 to an impersonal account with less detail in Excerpt 2 to an extremely concise account in Excerpt 3, written almost as a 'to do' list. The writer of Excerpt 1 writes for the purposes of record keeping and assessment. He can look back to see how to do the task, and he provides enough detail to be positively assessed by his tutor. Excerpt 2 also provides enough detail for a tutor to assess whether his work fulfils unit standard requirements. The purpose of keeping a careful account for billing purposes of tasks performed and hours worked is evident in Excerpt 3.

In a second interview, tutors commented on the Builders' Diaries' excerpts above. The interviews confirmed the developmental pattern that we describe. According to the tutors, students typically start with a detailed narrative personal style, which encourages the student to 'put themselves into' the diary/trade. This is part of taking on an identity as a carpenter. When the student moves into the workplace, writing becomes briefer, but still detailed enough for their tutor to assess whether they have achieved the various unit standards. One tutor viewed this change as happening through the model diary entries he provides, while another tutor reports that it 'sort of comes to them', as part of natural development. Finally, as the student becomes a professional, diary entries develop into a telegraphic list of tasks done, with careful costing of materials and labour: all the information that is needed for billing purposes. The insights from our qualitative analysis are thus borne out by the tutor interviews, as they are by quantitative analysis of our Builders' Diary corpus which we outline below.

Quantitative analysis of Builders' Diaries

Our quantitative analysis investigated use of seven language features in the Builders' Diaries. Table 6.2 shows their frequencies.

Table 6.2: ***Frequencies of seven language features in 44 Builders' Diaries (from Parkinson et al., 2017, p. 39)***

	Frequency per 1000 words
Personal pronouns (*I* and *we*)	18.5
You	1.7
Passive (with *be*)	6.6
Passive (*be* omitted)	4.5
Imperative/bare infinitive	16.6
Obligation modals (*must, need to, has to, should*)	4.5
Obligation verbs and phrases (*make sure, ensure, remember*)	3.4

Our quantitative analysis showed statistical evidence for different styles associated with different writers: a personal style (using full sentences, and the pronouns, *I* and *we*) as in Excerpt 1, and two impersonal styles, one using an elliptic form of the passive (without *be*) as in Excerpt 2, and one using imperative/bare infinitives as in Excerpt 3. The personal narrative style was achieved by use of full sentences and frequent use of personal pronouns.

There was a tendency for writers who used personal pronouns not to use passives or bare infinitives (Parkinson et al., 2017, p. 39). There was a strong trend (Parkinson et al., 2017, p. 40) for writers who used personal pronouns to use obligation modals (as in 'When we nailed the frames together, we **had to** make sure they were flush'.) This supports the purpose of reminding them how to do the task when they do it again.

There was a tendency for writers who used elliptic passive to also use imperative/bare infinitive; both are useful linguistic resources for writing concisely and impersonally. However writers who used these resources did not use obligation modals or obligation verbs and phrases, indicating that these writers are more developmentally advanced and have less need to instruct themselves (for the future) in how to do the task or mention cautions such as '**Make sure** you get it centred so you don't miss the purlin'.

In general, our quantitative analysis supports the conclusion reached in our qualitative analysis: the change from the educational context on campus to the workplace as apprentices is accompanied by a change from a narrative detailed personal style, to use of a bare, impersonal, point form, professional style. We also found support for our observation during our qualitative analysis of a trend from use of elliptic passives, to use of an even briefer point form style that employs the imperative/bare infinitive.

6.2.2 The 'move' analysis

The study outlined in this section is described in much greater detail in Parkinson et al. (in press). As mentioned above, the Builders' Diary is a daily account of what the students have done on the building site (see Appendix 10 for a sample diary entry). The Builders' Diary is also written by professional builders, and by teaching students to write it, tutors are not only building a habit of writing the diary, but teaching students how to do it. Other purposes of the Builders' Diary (mentioned above) are assessment, keeping a record for future reference, keeping a record in case of later court cases, job prospects and keeping a record of hours and materials for billing. The move analysis identified expression of these purposes in the diaries.

The purpose of the move analysis is to guide new students on what to include in the diary so we used the diaries of the students who the tutors regarded as the most proficient. Thus, we used the 10 Level 3 diaries which the tutors had rated most highly and the 10 most highly rated Level 4 diaries. Six moves were identified. These are shown in Table 6.3.

Table 6.3: ***Moves and their frequency in student Builders' Diaries (from Parkinson et al., in press)***

	Number of diaries that contained the move (out of 20)
Move 1: Setting the context of the building work	**19**
Move 2: Detailing materials and equipment used in the building work	**20**
Move 3: Detailing cost of the building work	2
Move 4: Detailing building work	**20**
Move 5: Evaluating building work	6
Move 6: Personal comment on the building work	9

As can be seen from Table 6.3, only Moves 1, 2 and 4 are frequent moves. These three moves account for 99% of the words in the diaries in the data set. In what follows, therefore, we focus only on these three moves.

In move analysis, writers can achieve each move in a number of ways. These are referred to as 'strategies' (also known as 'steps'). Examples of the most frequent strategies that students used to 'Detail the building work' (Move 4) were, to 'Detail the task' (Strategy 1), 'Detail the method' (Strategy 2), 'Detail the purpose' (Strategy 3) and 'Detail the measurements' (Strategy 8).

To illustrate the Move/Strategy analysis, in Table 6.4 we include all the Moves and Strategies that occurred in 15 or more of the 20 Diaries we analysed. For details about the other, less frequent strategies, please consult Parkinson et al. (in press).

Table 6.4: ***Strategies and their frequencies in student Builders' Diaries***

	Number of diaries that contained the move/ strategy (out of 20)
Move 1: Setting the context	**19**
Strategy 1 Detailing date/time of day	**16**
Strategy 5 Identifying work as a stage in a sequence	**15**
Strategy 6 Detailing the social context (team/ tutor/employee/ suppliers/subcontractors)	**16**
Move 2: Detailing materials and equipment	**20**
Strategy 1 Detailing materials/fixings	**20**
Strategy 2 Referring to tools and equipment	**19**
Move 4: Detailing building work	**20**
Strategy 1 Detailing task	**19**
Strategy 2 Detailing method	**19**
Strategy 3 Detailing purpose/reason	**20**
Strategy 8 Detailing measurements	**20**

In any diary entry, a writer can use one strategy to achieve a move, or more than one strategy to achieve it. A writer can also use the same strategy more than once in a single diary entry. See

Appendix 11 for an example of a move/strategy analysis of one diary entry. In it, both Strategy 1 and Strategy 5 of Move 1 have been used. Similarly, Strategies 1 and 3 of Move 4 have been used. In addition, this diary entry uses Strategies 1 and 3 of Move 4 more than once. In Table 6.5 we include examples from our data set of all strategies listed in Table 6.4.

Table 6.5: ***Examples of strategies in student Builders' Diaries***

Move 1: Setting the context
Strategy 1 Detailing date/time of day a. Wednesday 10th September 2014
Strategy 5 Identifying work as a stage in a sequence b. Now that we have set out profile boards in the correct places, we were now ready to…
Strategy 6 Detailing the social context c. Andrew finishes while me and Seb carry on straightening the rest of the frames with braces.
Move 2: Detailing materials and equipment
Strategy 1 Detailing materials/fixings d. Also fastening using purlin screws on each rafter
Strategy 2 Referring to tools and equipment e. Using a builder's automatic level (dumpy), we checked the heights of each 4 corners of the house. By using a staff and level with the dumpy, we checked the ground level. We found this by checking the finished floor level using dumpy, staff and ruler.
Move 4: Detailing building work
Strategy 1 Detailing task f. Each Jack-truss was then nailed into place along the top plates, they were then tacked into place along the length of the hip.
Strategy 2 Detailing method g. [Once] the Watergate has been cut at 45 degree angles and stapled over the frame of the window, sill tape is applied to the corners of the framework in preparation for the window.
Strategy 3 Detailing purpose/reason h. These only had to be done to the exterior walls as they are the only load bearing walls.
Strategy 8 Detailing measurements i. The stud measurements were 2334mm and 2249 mm, which was good to let us cut an angled top plate that sat at 18° pitch.

"This analysis has clear pedagogical value, and should be useful to carpentry tutors in teaching Builders' Diary writing"

This analysis has clear pedagogical value, and should be useful to carpentry tutors in teaching Builders' Diary writing. Because it contains the three most frequently used moves, and all frequent strategies within those moves, the examples in Table 6.5 can guide the diary writing of carpentry students when they first start to write diaries.

6.3 Explanations and analogies in trades teaching

In this section we outline our analysis of an important feature of teaching in the trades: analogies used by trades tutors in their teaching. Table 6.6 shows the results of 23 interviews about the analogies tutors use in their teaching. As can be seen, all tutors interviewed in automotive technology and electrical technology reported using the flow of water as an analogy for the flow of electricity. One fabrication tutor reported the use of the analogy of the flow of water as a representation of heat. Unexpectedly, the plumbing tutors interviewed reported that they do not use analogies. This needs further investigation for example by classroom observation.

Table 6.6: *Analogies in teaching the trades*

Trade	Kind of analogy	Number of tutors interviewed	Number reporting use of analogies
Automotive technology	Tutors use the flow of water as a representation of current.	6	6
Electrical technology	Tutors use the flow of water as a representation of current.	5	6
Fabrication	One tutor reported using the flow of water as a representation of heat.	4	1
Plumbing	Despite substantial physics knowledge in the curriculum, no analogy use reported.	2	0
Carpentry	Tutors reported that there is not much opportunity to use analogies	6	0

diameter terminal sensor measuring regulations carpentry sensor clamping valve assessment trap carpentry level section

In what follows, we outline the analogies that tutors reported using and which they explained using pencasts. These include:

- analogy between the attraction/relationships between people and the force relationships between electrical charges
- analogy between the flow of fluid in a pipe and the flow of electricity in electrical circuits
- analogy between water running out of a pipe and heat escaping from a house
- analogy between the inertia of a car and the inertial effect an inductor has on a circuit.

Analogies for electrical concepts

There were a number of analogies identified for electrical concepts. We divide these into anthropomorphic ones, where an analogy is made with human behaviour, and non-anthropomorphic ones.

Anthropomorphic analogies

a. The mapping of the relationships between people and force relationships between charges

In this analogy attraction between people was used to explain the attraction between positive and negative charges (force of attraction, opposites attract, etc.). The analogy is a weak one, because it cannot be extended easily and also there is no mathematical relationship that can be mapped. Attributes (opposite gender and opposite signs) are the only things that can be realistically mapped. The relationship (attraction), while always true for charged particles is not always true for people. One is physical and the other emotional.

b. The mapping between people's behaviour and the behaviour of a resistor in a circuit

In this analogy, the tutor compared the action of a resistor in a circuit to the behaviour of a person who 'uses' your friendship and 'takes all your cash'. The resistor was referred to as the user in the circuit that used the current and drained the battery of power. This too is a weak analogy, as the relationship between power dissipation and resistance cannot be adequately mapped from the base domain (behaviour of friends) to the target domain (resistive circuits).

While it is beneficial to include reference to people in trades and engineering-related teaching, the use of analogies that try to develop a map between the world of people and the physical world must be done with care.

c. The movement of people as a representation of electron movement in a wire

In this analogy, the movement of people is used to describe the motion of electrons in a wire. This is a commonly used analogy worldwide (Podelefsky 2004) and it has several conceptual benefits. The first is that the speed of people moving down a corridor can be mapped directly to the speed that electrons have in wires. There is a mapping of the attributes (narrowness of wires to narrowness of corridors, speed of electrons to rate of people flow), but also there is a mapping of the relationship between the speed of the particles in both cases (electrons and people) to the narrowness of the wires and the corridors. This makes the analogy a fairly good one, as it can be extended.

Non-anthropomorphic analogies

The use of the fluid flow analogy in teaching electrical circuits

This analogy compares the flow of water in a pipe to the flow of electricity in a circuit. All tutors who taught basic electrical circuits actively used this analogy, or had used the analogy before.

Five admitted to learning the analogy from the tutors who taught them. There was a positive sense that analogies learned from their own tutors were valuable "teaching nuggets" passed on from generation to generation. This provides evidence of a kind of apprenticeship in trades teaching that seems to come out when tutors talk about their favourite analogies.

The strength of the fluid flow analogy is that there is not only a good mapping of attributes (see Figure 6.1), but that there is also a strong mapping of relationships as well. This mapping of relationships takes place with mathematical relationships as well. Learners find it easier to conceptualise water flowing through a pipe, and so can then make sense of electric current, which is to do with particles they cannot see (see Table 6.7). However, there are also some pitfalls of the analogy, which some tutors did not consider in their teaching. The concept of voltage is abstract and often mapped with the pressure in the pipes which is used to drive the water in the fluid flow analogy. When mapped onto the electric circuit, some tutors referred to voltage as pressure, which gives the impression that voltage is a force, which it is not.

Table 6.7: ***Mapping between the fluid flow analogy and a simple electric circuit***

Electrical Reality	Kind of analogy	Fluid Analogy
Electricity	Attributes	Water
Battery		Reservoir
Wires		Pipes
Resistor		Constriction in the pipe
Voltage across		Pressure across
Current through		Flow rate
Resistance of		Narrowness of
Conceptual: Current is determined by voltage across the resistor and the resistance of the resistor	Relations	Conceptual: Flow rate is determined by pressure across the constriction and the narrowness of the constriction
Physical Connections: Battery is connected to wire, which is then connected to a resistor which is connected back to the battery		Physical Connections: Reservoir is connected to a pipe which is then connected to a constriction which is connected back to the reservoir

Lastly, research into students' understanding of basic electrical concepts has been shown in previous research (Podelefsky 2004) to be affected by the choice of electrical analogy (fluid flow or people movement). Students who have been given the fluid flow analogy had a deeper understanding of potential difference and energy in electric circuits, while those who were taught using the people movement analogy showed a deeper understanding of electric current and resistance in circuits.

Tutor-invented analogies: Heat flow analogies

Figure 6.1 shows an analogy for a thermal short (heat escaping from a hole in a building for example) used by an engineering tutor. Heat flow analogies also draw on the fluid flow model and in this analogy, water is poured on top of a sponge that is blocking a vertical pipe. It is then allowed to dribble through at a fairly slow rate. However, when the sponge is pierced and a hole made, the water flows through at a very fast rate. In this analogy, the sponge represents the insulation of a house, which lets heat escape at a slow rate. As soon as a thermal short is made by piercing the hole (for example a place where a window does not shut properly, the gap under a door or where the insulation is not properly fitted), the heat escapes very much faster.

Figure 6.1: ***Tutor analogy between water flowing out of a pipe and heat flowing out of a house***

Extension of the water in pipes analogy to include inductors and capacitors

At least two tutors had given thought to developing the resistance-fluid flow analogy further, in order to include more complex electrical components like capacitors and inductors. The understanding of analogies by the learner requires a certain amount of visualisation. This is also true of tutors who have to see how their analogies can be extended. Figure 6.2 shows two analogical inventions that extend the fluid flow analogy. The first is a capacitor and the second an inductor. In addition, the tutor also extended his analogy to map series and parallel relationships for capacitors and inductors as well as for resistors.

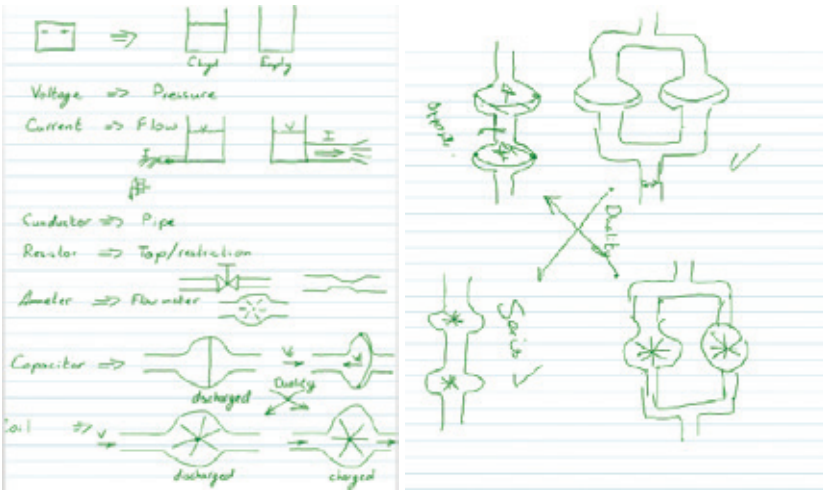

Figure 6.2: ***Analogy between fluid flow and electrical flow in capacitors and inductors***

Integration of analogical representation with visual representation

In this section, we discuss examples of analogical representation being integrated with visual representation. As discussed in Section 6.4.1 on the use of visual meaning in teaching in the trades, tutors often used several representations of a concept (diagrammatical, textual and mathematical). An analogical representation can be considered as simply another conceptual representation.

A first example involves the explanation of inductance in an automotive class. In this class, the tutor used the analogy of pushing a car to represent the action of an inductor in a circuit. The key mapping is between the inertia of the car and the inertial effect the inductor has on the circuit. A circuit diagram was used and the circuit was demonstrated showing how the action of the inductor affected the circuit. The physics was explained and the analogy was used. No mathematics was used.

Analogies are often made to form real tactile teaching tools in the classroom. An example of this is the demonstration of the piercing of the sponge in the thermal short experiment described above and the actual construction of a fluid flow circuit that works.

6.4 Visual expression of meaning

Visual expression of meaning is extremely important in trades teaching. This has to do with the usefulness of the visual mode in expressing complex concepts, and with its usefulness in providing a visual reference (perhaps more concrete) to support textual expression of meaning. In this section we consider expression of visual meaning in two contexts: course materials (6.4.1) and student writing (6.4.2).

6.4.1 Visual expression of meaning in course material

In this section, we provide an overview of the visual literacy demands of trade' course material and report on two interesting aspects of teaching visual elements; the first is the teaching of circuit and wiring diagrams in auto-electrical and electrical trades and the second is the use of multiple representations of key concepts in the automotive and fabrication trades. Our reference to multiple representations refers to how ideas and concepts can be represented not only through the visual mode and the written mode, but also through a number of different visual types (e.g. photograph, drawing, graph, chart, isometric view, etc). To do this, we looked at three sources of data. The first source was the interviews we conducted with the 25 tutors at the beginning of the study (see section 6.1). Our second source of data was an analysis of the visual elements in a sample of trades learning and teaching booklets selected to provide a mixture between introductory concepts as well as more advanced concepts (see Table 6.8). This analysis produced evidence of the use of multiple representations of concepts across the four trades. Our third source of data was classroom observations to investigate the way tutors use multiple representations in their teaching.

Table 6.8: *Sample of course booklets selected for analysis*

Trades	Booklets selected
Automotive (3)	Underbody Hydraulics Manual Transmissions
Carpentry (2)	Site Preparation Exterior
Plumbing (2)	Pumps Backflow
Fabrication (2)	Basic Fabrication Machining

Course materials in all four trades investigated in this project relied in one or more ways on the production and interpretation of diagrams. This is particularly true of those trades that rely heavily on understanding more complex concepts such as is the case in automotive technology and the electrical trades. Typically, trades rely on knowledge of technical drawing conventions, three dimensional representations of artefacts and objects, plans and the transition from two dimensional representations to three dimensional thinking, or from one representation of an idea to another.

What the tutors say: Data from the interviews

Tutors identified two kinds of diagrammatic interpretation. The first is the drawing of products, artefacts and structures using standard technical drawing methods. In fabrication, the interpretation of such drawings is through the implications the designed product has for the manufacturing process. This is true for carpentry as well as plumbing, where the interpretation of diagrams is focused on shape and size. The second kind of diagrammatic interpretation is that of diagrams that represent abstract concepts. This is particularly true in the electrical and automotive trades, where there is some reliance on the understanding of abstract physics concepts.

In the electrical trades (electro-technology and auto-electrical), where the interpretation of diagrams relies on the understanding of abstract concepts, tutors identified the interaction with the diagram as being of importance as well as the ability to produce adequate drawings of circuits and wiring diagrams. Although the emphasis is greater in these trades on this development of diagrams in addition to being able to interpret diagrams in connection with abstract physical concepts, there was an acknowledgement in the interviews that this was not sufficient.

> In electro-technology you need to be able to interact with the diagrams, there's a lot of diagrammatic interpretation and also the production of diagrams. (Electrical trades tutor)

Table 6.9 summarises the kinds of visual elements that were considered important in each trade as well as some of the problems identified.

Table 6.9: ***Important visual elements by trade***

Trade	Kinds of visual elements	Problems
Automotive technology	3-dimensional representations of components; conceptual diagrams; graphs; charts; component operation charts; schematics.	Some difficulty with moving from 2 dimensions to 3 dimensions.
Fabrication	Formal technical drawing of artefacts as part of the design process; 3 dimensional representations of components and artefacts;	Have difficulty interpreting the manufacturing process from the drawing of the artefact or product.
Carpentry	Reading and interpretation of plans and projections; 3 dimensional representations of structures; drawings with perspective.	Difficulty with moving from 2 to 3 dimensions.
Plumbing	Plans; developments (nets); exploded views; simple isometric views.	Not enough practise at interpreting plans; no experience in technical drawing.
Electro-technology	Circuit diagrams; wiring diagrams; conceptual diagrams of components; graphs; charts	Difficulty relating diagrams to each other; difficulty interpreting circuit diagrams.

A noticeable complaint by tutors was the lack of preparation given to the kind of production of diagrams necessary for the curricula that they teach. While it was accepted that there is a bit of a problem translating between dimensions, visual literacy in general was not considered a major issue in some trades.

> ...basically diagrams are usually good. Most of our trainees are visual learners...Visual literacy is the least of our problems in this trade. If someone's having a particular problem we draw it. Quick sketch and away we go. (Plumbing tutor)

Analysis of the learning materials: Trends and differences across the four trades

All of the kinds of visual elements identified by the tutors were also found in the sample of nine booklets analysed. A breakdown of the visual elements present in the learning and teaching

materials is summarised in Table 6.10. Due to the range in size of the booklets selected for analysis, the comparison between trades is made in terms of the number of images per 1,000 words. What is noticeable is that the number of images is variable, with plumbing having an unusually low number of images per 1,000 words (2.64), compared with the highest, 10.25 in fabrication. The average of 7.31 images per 1,000 words across the four trades is a high number when compared with other studies (e.g. Bezemer & Kress, 2009), where, for example, in English language textbooks for GCSE, the number of images per page is 0.74. This would be approximately 2.96 images per 1,000 words. Almost all the text in trades writing appears to be dedicated to describing and explaining the diagrams presented. This aligns with Bezemer and Kress's (2009) findings that since the 1930s the average density of images in English language teaching textbooks has risen from 0.03 per page to 0.74 per page in the 2000s. The implication of this is that the design of textbooks is increasingly organised around images rather than around the text itself.

Table 6.10: ***Summary of the use of visual elements in each trade***

	Automotive	Carpentry	Plumbing	Fabrication	Total
Total words	36,344	59,231	13,281	34,034	142,890
Total images	251	410	35	349	1045
Visuals/1000 words	**6.91**	**6.92**	**2.64**	**10.25**	**7.31**
Photographs/1000 words	0.80	2.58	0.00	3.41	2.09
Drawings/1000 words	6.11	3.97	2.26	6.76	5.02
Graphs & tables/1000 words	0.33	0.24	0.38	0.41	0.31

Sixty-eight percent of all the visual elements found were drawings, 28% photographs and only 4% graphs, charts and tables. Automotive technology and carpentry had similar numbers of visual elements (6.9 images per 1,000 words), with plumbing very low at 2.64 and fabrication higher (10.25). This may be due to the nature of the different trades, but the sample is too small to make this judgement. However, while carpentry and automotive have about the same number of visual elements, the visual type used in each is very different. Eighty-eight percent of the images in automotive technology are drawings, compared with 57% in carpentry. In general, photographs were found at the beginning of units, where basic concepts were being addressed. Conceptual development was usually conducted with a drawing as the agent rather than a photograph. Tables, graphs and charts were mostly found at the end of the booklet.

The kinds of drawings used

Three different kinds of drawings were found in the sample: oblique projections of artefacts, section views and schematic drawings. Table 6.11 shows the proportional use of different kinds of visual elements used in each trade.

Table 6.11: ***Detailed analysis of visual elements used***

	Automotive	Carpentry	Plumbing	Fabrication	Total
Total	267	470	32	421	1118
Drawings showing oblique projection	76	194	3	106	379 (33%)
Photos showing oblique projections	29	111	0	112	252 (23%)
Section views (cutaway views, usually of the front)	117	102	26	128 (4 photos)	245 (22%)
Schematic overview	21	11	3	0	35 (3%)
Instances with connection between images	6 (31 images)	11 (35 images)	6 (17 images)	39 (151 images)	62 (6%)
Drawings of human interaction	5	5	0	27	37 (3%)
Photos of human interaction	2	44	0	48	94 (8%)
Multiple representations of the same idea	11	3	0	0	14

Most of the visual elements used were drawings (68%) and of these most were oblique projections (36%). Section views, providing an image of a cutaway of a component (showing how the component worked) made up 23%. While oblique projections were often used to introduce a component, the explanation of the way the component worked was most often carried out using section views (see Figure 6.3). Few drawings showed any humans interacting with an artefact (hands usually), but those that did, did so in order to describe a process as shown in Figure 6.4.

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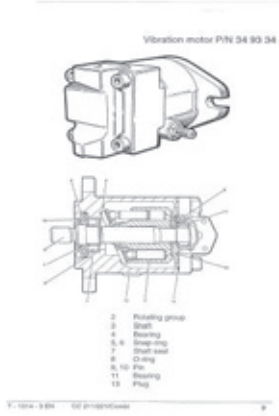


Figure 6.3: Oblique projection with section view, showing two representations of the same artefact: [Automotive Technology workbook extract (AT 4210 Heavy Vehicle Hydraulics and Pneumatics Systems 1, 2015, 47) Reprinted with permission from Wellington Institute of Technology.]

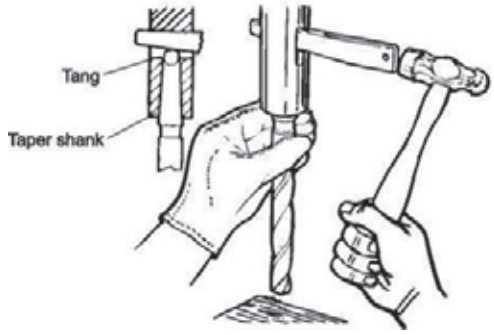


Figure 6.4: Oblique drawing showing a procedure: [Figure 23 Removing a taper shank: Machining workbook extract (240712 Competenz National Certificate in Machining (level 2) Module 11, 2012, 24) Reprinted with permission from Wellington Institute of Technology.]

Schematic views were mainly used to show systems of interacting components in automotive (Figure 6.6). In carpentry this would equate to plans of houses (Figure 6.5), in plumbing to plans of plumbing systems. No similar schematic overviews were seen in fabrication, apart from the side view of a lathe.

Figure 6.5: Deposited Plan: [Carpentry workbook extract (ITP Carpentry development consortium; Site Preparation student workbook, n.d. 51) Reprinted with permission from Wellington Institute of Technology.]

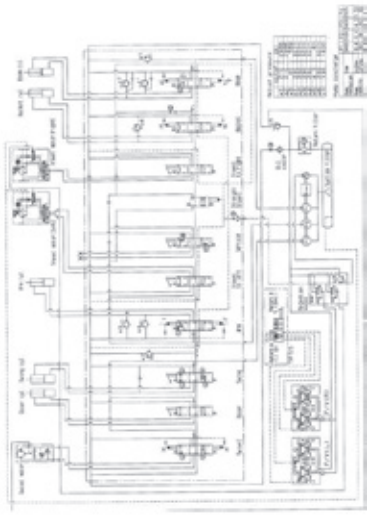


Figure 6.6: Hydraulic layout plan: [Automotive Technology workbook extract (AT 4210 Heavy Vehicle Hydraulics and Pneumatics Systems 1, 2015, 35) With permission from Wellington Institute of Technology.]

Figures 6.5 and 6.6 compare a schematic plan used in carpentry with a similar schematic layout of an hydraulic circuit used in automotive technology. In the building plan the relationship between objects is spatially determined, while in the hydraulics circuit the spatial relations are more functional and determined by the vehicle.

The use of photographs in the texts

Surprisingly, fewer photographs than diagrams were used in the texts studied. The role of these photographs was largely introductory and in the case of fabrication, photographs were used to show students how to perform particular procedures. An example is shown in Figure 6.7.

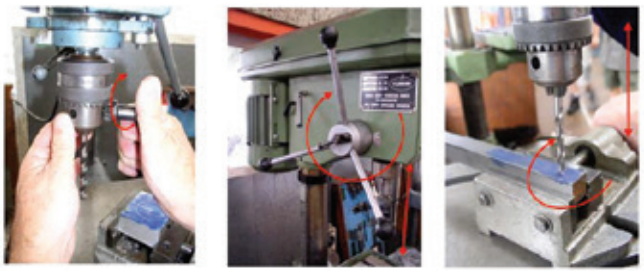


Figure 6.7: ***How to perform a procedure:*** [Basic Fabrication workbook extract (No date, no page number) Reprinted with permission from Wellington Institute of Technology.]

In automotive technology, the use of photographs was predominantly at the beginning of the texts, leading to more complex and more abstract images such as section views and graphs later in the text. This could possibly be a deliberate scaffolding of images from more concrete to more abstract through the booklet. In fabrication and carpentry, this did not take place and in plumbing, no photographs were used.

The use of multiple representations in the texts

There were 14 instances of the use of multiple representations in the texts selected, all of which were in either automotive technology (11) or carpentry (3). Complementary representations (Ainsworth, 2006) of objects or artefacts were either in the form of two different drawings of the same object (Figure 6.8), or sometimes in the form of a photograph and a drawing together. These complementary representations provided both identification of the artefact as well as an understanding of how it works. In automotive technology, the simultaneous representation of hydraulic circuits as shown in Figure 6.8, helps the student to identify the individual components of a system as well as see the system itself.

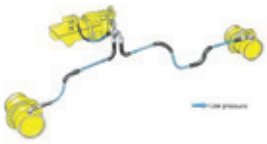
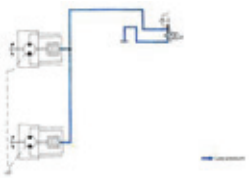
	
Schematic, real looking hydraulic circuit	Schematic, abstract hydraulic circuit

Figure 6.8: ***Hydraulic circuit:*** [Automotive Technology workbook extract (AT 4210 Heavy Vehicle Hydraulics and Pneumatics Systems 1, 2015, 42-43) Reprinted with permission from Wellington Institute of Technology.)]

The oblique representation provides a 'real' view of the system, while the schematic representation uses standard abstract symbolism to denote the different components, and the fluid lines are simply shown as solid lines on the diagram. The complementary use of the more abstract circuit diagram with the component symbols helps the student learn to interpret conventions used in the drawing of hydraulic circuit diagrams. In this case, the two representations together enhance understanding as well as provide complementary views on the concepts involved (Seufert, 2003; Ainsworth, 2006).

Figure 6.9 shows a sequence of connected images for a gear box represented with a graph. The graphs complement the sequence of images that show the mechanics of gear changing, and also enhance the students' understanding by providing a conceptually different view of the same process. The whole process is understood by connecting what is happening at a mechanical level (Figure 6.9A) with what is happening at a graphical level (Figure 6.9B). Understanding is enhanced by making connections between the graphs in Figure 6.9B.

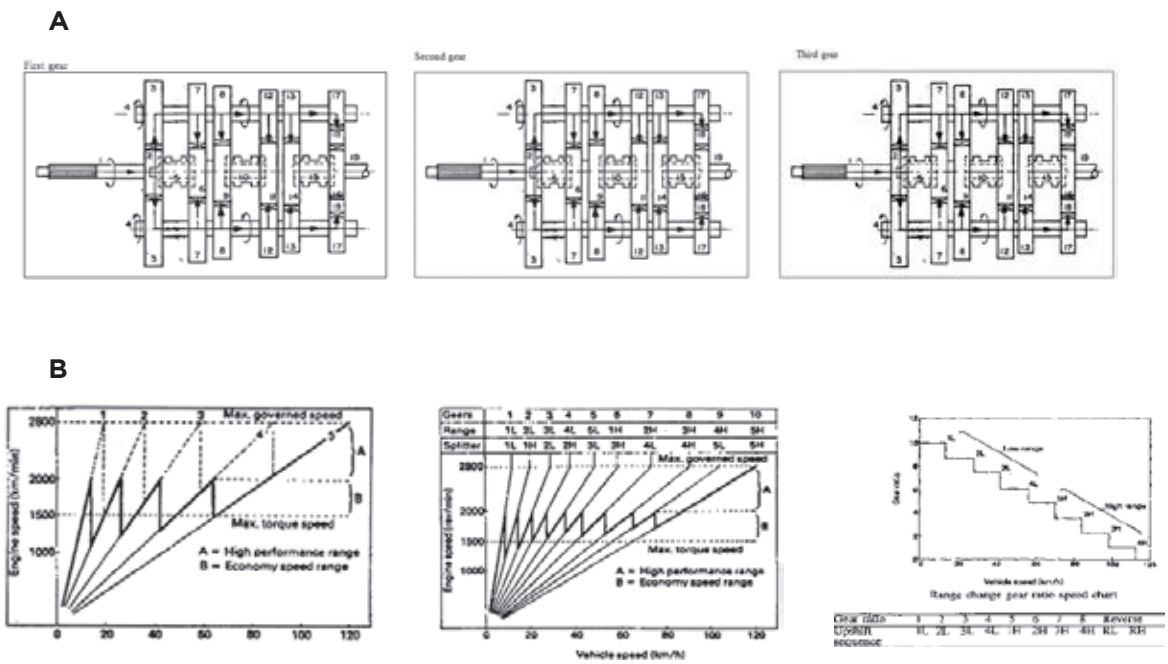
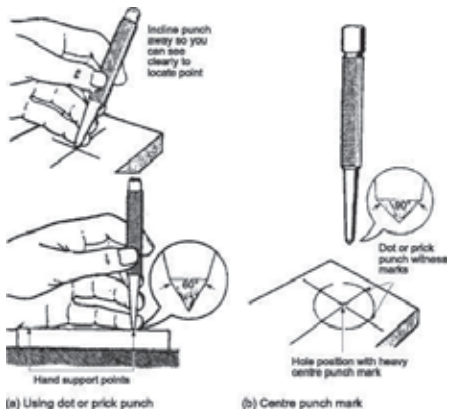


Figure 6.9: ***Multiple representations of the same concept in graphical form:*** [Automotive technology workbook (AT 4201 Engine Performance (III) 2009, 72) Reprinted with permission from Wellington Institute of Technology]

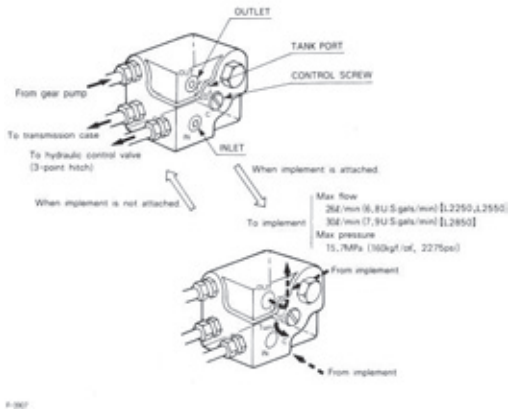
installation consortium supply reinforcing bearing
flow frame accordance angle compound fixing foundation
formwork bracing specifications construction voltage

Connections between images

Apart from multiple representations of the same concept as mentioned above, instances of connections between images in the texts fell into two categories, temporal and functional. Temporal connections occurred where images formed part of a sequence of events in a machine, (for example positions of gears at various stages), or more commonly where parts of a procedure were explained. Both line drawings and photographs were used to make these connections (Figure 6.10).



(Source: Machining workbook extract (240712 National Certificate in Machining (level 2) Module 11, 2012, 32) Reprinted with permission from Wellington Institute of Technology)



(Source: Automotive Technology workbook extract (AT 4210 Heavy Vehicle Hydraulics and Pneumatics Systems 1, 2015, 31) Reprinted with permission from Wellington Institute of Technology.)

Figure 6.10: Connected Images

Sometimes the connection between images was functional, as shown in the example in Figure 6.11, where the four diagrams show different ways of mounting a chuck on different types of spindle. The process is the same; just the tool is different.

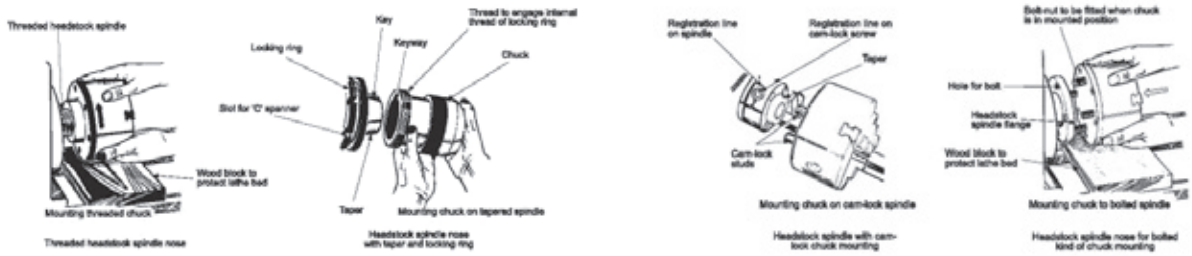


Figure 6.11: ***Functional connection between images*** [Machining workbook extract 240712 National Certificate in Machining (level 2) Module 11, 2012, 49) Reprinted with permission from Wellington Institute of Technology.]

The use of graphs, tables and charts in the texts

While graphs, charts and tables accounted for only 4% of the images, they were not unimportant. Understanding the graphs, charts and tables was essential to understanding each unit of work investigated. In automotive technology, graphs were presented at the end of the unit of work, in conjunction with other representations. While there was low use of these visual elements, they were important to the texts analysed and often appeared at the end of the section being studied once students had a good grasp of concepts. This is supported by observation data where tutors spent time showing students how to interpret these kinds of visual elements.

Representations of people in the images

In both photographs and in drawings, people were present in demonstrating processes, procedures and ways of using tools. This was true in both carpentry and in fabrication, where 9% of photographs were used to show people doing things. Fewer drawings with people were used (3.5%) and the bulk of these were in fabrication.

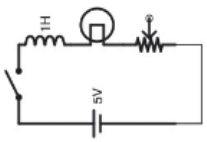
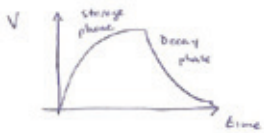
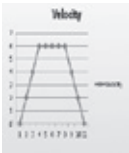
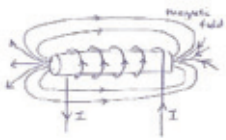
Examples of the use of multiple representations in teaching

Multiple representations have traditionally been used as a way to develop students' conceptual understanding of a situation and, more importantly, to teach students how to develop from this understanding, a mathematical model of the situation they are dealing with. Central to this are the diagrammatic representations of concepts and the models that are developed in conjunction with these diagrams.

Teaching using multiple representations

There is close alignment between the ways electrical concepts are taught in engineering physics and in auto-electrical technology; often the same analogies are employed in the two different contexts. From classroom observations, tutors appeared to regard multiple representations as an effective way to teach conceptually difficult material. In the first example, a class on the action of an inductor in a circuit was observed and the tutor's use of multiple representations of induction concepts was observed and recorded. Table 6.12 shows representations that were all used in this class on induction. No mathematics or phasor diagrams were used, as would be the case in a standard physics or engineering approach to the topic.

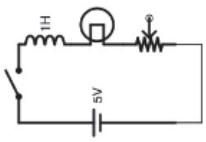
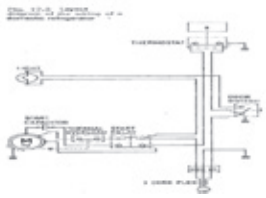
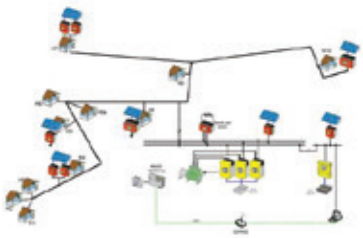
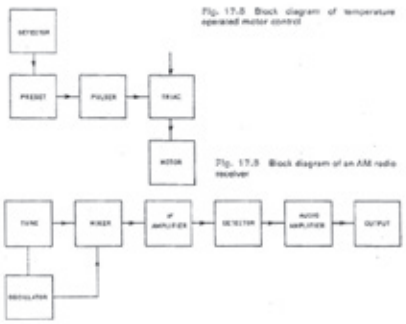
Figure 6.12: ***Multiple representations of inductance*** (Images taken from classroom observation)

Circuit diagram showing inductor in the circuit 	Graph showing the action of the inductor 	Actual physical demonstration of inductance
Analogy mapping the inertia of the car with the inertial effect of the inductor 	Schematic of inductor construction (with verbal explanation) 	Written and verbal explanation of the effect of an inductor in a circuit

The teaching of circuit diagrams in electro-technology

In the electrical, as well as the auto-electrical trades, emphasis is placed on the production and interpretation of multiple representations of circuits, each representation having a particular purpose. Table 6.13 shows the different kinds of diagram that were taught in an electro-technology class to trainee electricians. At least five different kinds of circuit representation need to be learned by the students. In addition to being able to produce and interpret these five representations, students must be able to visualise one kind of diagram by looking at another. To accomplish this, both electrical and auto-electrical tutors specifically teach the production and interpretation of diagrams.

Figure 6.13: ***Different kinds of diagrams*** [Electrical Technology workbook extract (Drawing Diagrams; 2014) Reprinted with permission from Wellington Institute of Technology.]

Circuit diagrams provide a schematic layout of the circuit from a theoretical perspective 	Wiring diagrams: provides a physical layout of the circuit 
Location diagrams : provides information regarding the connection points and voltage at these points	Single line diagrams: diagrams that show a single line for all three phases, instead of three lines, one for each phase. (Sourcehttps://www.researchgate.net/figure/268503424_fig2_Figure-2-Single-line-schematic-diagram-of-Gaidouromantra-microgrid-Kythnos-island) 
Block diagrams: provides a systems layout of the circuit 	

In teaching electro-technology, there is an emphasis on function and purpose. There is also a focus on trial and error and using the process of elimination to find a fault, along with a strong reliance on procedural knowledge rather than conceptual knowledge. Students are encouraged to use algorithms rather than operate from first principles, leading to a much quicker outcome in terms of fault finding. Being able to move between diagrams is taught explicitly as it is integral to their professional lives. This is different to the way students have learned about electric circuits in school, where there has been an emphasis on conceptual and theoretical knowledge.

6.4.2 Visual expression of meaning in student writing[1]

Our analysis of images used in the Builders' Diary was highly revealing. It confirmed our finding (outlined in 6.2 above) that the diaries of the Level 3 on-campus students were more 'personal' than those of the Level 4 students. The analysis also showed numerous compositional regularities, suggesting the extent to which the diary writers share and are able to reproduce culturally-shared visual meanings. This section outlines our findings with regard to expression of representational, interpersonal and compositional meaning, before discussing the implication of these findings.

As a reminder to the reader of our data set, images in the diaries of 10 Level 4 students (who are apprentices) and 33 Level 3 on-campus students were included. We used 2,000 words from each diary and included all images in each 2,000-word sample. This produced a total of 1,739 images, of which 810 were drawings and 929 were photographs. Photographs were coded for whether they contained people or not.

Representational meaning

As Table 6.14 shows, overall the Level 3 students used more images in their diaries (an average of 44 per diary) compared to the Level 4 students (28 per diary on average). The Level 4 students produced more photographs without people (on average 16 per diary) compared to Level 3 diaries (6 per diary). By comparison the Level 3 students produced more drawings (on average 22 per diary) than the Level 4 students (10 per diary). Level 3 students also used more photographs that included people (18 per diary) than the Level 4 students (2 per diary).

Table 6.14: ***Three types of image produced by Level 4 and Level 3 trainees***

	Drawings / sketches	Photographs with people	Photographs – no people	Total
Mean number/ apprentice(10)	10	2	16	28
Mean number/on-campus trainee(33)	22	18	6	46

This greater inclusion of people in the photographs in Level 3 diaries suggests a more personal diary in which writers represent themselves and their classmates as part of the building site. Combined with the greater use of personal pronouns in the texts of their diaries (described in section 6.2 above), we regard this as functioning to situate writers in their diaries and on-site.

[1] A fuller discussion of the findings in this section can be found in Parkinson, Mackay & Demecheleer (in review).

We speculate that by displaying themselves on-site in images and by using the pronouns I and we to describe themselves as the people doing the work described in the diaries, Level 3 students claim an identity as a carpenter.

In contrast, the diaries of the Level 4 students are more impersonal, both in the dearth of photographs that include people and in the use of a telegraphic written style that includes few instances of I and we. It seems that with the change to a workplace context where their identity as carpenters is more firmly established, students no longer use personal images and personal pronouns to assert their identities as carpenters.

Being able to include photographs of their building work, is an advantage to the diary writer in being able to provide proof of what they have been doing on site. Photographs can provide evidence that the diary writer is able to do certain building tasks and can be credited with the corresponding unit standard. Later on, qualified builders can use photographs to provide proof to council building inspectors, for example, of the plumbing or electrical work which is inside the dry wall of the house.

Photographs do not however remove the need for sketches, which show a subtly different kind of information. This includes, firstly, planning of measurements (Fig. 3.7) and secondly, a more abstract outline of the work, showing only the salient features (Fig 3.3).

Interpersonal meaning

As outlined in section 3.2, Kress and van Leeuwen's (1996) framework makes a distinction between images in which a human participant 'demands' a social response from the viewer by 'looking at' or 'making eye contact with' the viewer, and images that make no such social demand, instead 'offering' information. Very few images (24 out of 1,739) in the data set were demand images. The few demand images were all found in the diaries of four Level 3 students. They were posed as team photographs, in which the depicted participants look at the viewer. Their presence could perhaps be viewed as part of the building of a cohesive team of 'mates', which is important in the trades.

In contrast, the majority of images were 'offer' images. This included all drawings, and all photographs that did not include people. It also included most photographs that contained people who were not facing the camera. Instead the focus of the photograph is on the work that the people are doing or have completed. So although the Level 3 students' diaries were more personal in the sense of containing people, these images did not make the people the focus of the image and instead functioned to depict the producer and his/her classmates as an unremarkable part of the building site.

Compositional meaning

We focused on three aspects of compositional meaning in the diaries. These were firstly, placement on the page, secondly, the relationship of images with other images close by, and thirdly, the relationship of images with surrounding text.

With regard to placement on the page, as described in section 3.2, an image or text on the left of the page is viewed as 'given' or known information, while an image or text on the right is viewed as new information. Our findings were that half of the images in our data set were on the left (as in Figure 3.1), suggesting that what is depicted in the image is known, while the written description of what was done is 'new'. The image may in fact be the more known entity, as it depicts what the producer has already experienced on-site. A further 24% of the images

were the other way about (as in Figure 3.2), with the written description on the left, thus viewed as known, and the image on the right, thus viewed as new.

A further 10% of images were placed at the bottom of the page, in 'real' position with another image or text above in 'ideal position'. In the case of Figure 3.3 for example, the photograph is in 'real' position, displaying the reality of how the dwangs were laid out on the building site; the diagram above is in 'ideal' position, showing the writer's plan or abstract representation of the layout of the dwangs.

The second aspect of compositional meaning which we considered was the relationship of an image to other images. As outlined in section 3.2, we coded 3 possibilities including temporal relationships (Figure 3.4), spatial relationships (Figure 3.5), and overview-detail relationships (Figure 3.6). The most frequent image-image relationship was a spatial one (56% of images), followed by a temporal relationship (27%) and an overview-detail relationship (13%). This suggests that writers' major concern was with how the elements of the house fit together followed by how the steps in the task were sequenced.

The third aspect of compositional meaning that we considered was the relationship of image to text. Most of the images in the data set did have a meaning relationship with text in which they were found (93% of images). Using van Leeuwen's distinction (1991), we distinguished an image-text relationship of elaboration (in which the text and image express the same or similar meaning) and extension (in which the image and text are about different but complementary things). Most images (83% of images) were in a relationship of elaboration with the text; that is there was the same meaning in the two modes. Together they provide a fuller more comprehensible account, offering evidence of what the student has achieved on the building site, making the account more convincing to the tutor and more useful and detailed for the student if they refer back in future to see how they did the work. Only 10% of images were in a relationship of extension. Figure 3.7, which shows an example of this, was written by a highly experienced carpenter; for him there was less need to express the same meanings visually and in words, and the two modes thus express different but complementary meaning.

Discussion of findings

Our findings show that there were strong regularities in expression of visual meaning in the Builders' Diaries in our data set. These included a tendency to place images to the left of the page, suggesting a view by the writers that the visual mode depicted known, already experienced, information and the written mode was new, or less familiar. Secondly, there was a trend for the relationship between images to be a spatial one, suggesting that working out how the parts of the building fit together was important for writers. Thirdly, there was a trend for image and text to express the same meaning, suggesting that this fuller, more detailed account using two modes is useful to both tutor and student.

There was a tendency for the more experienced Level 4 students to favour photographs without human participants, just as their writing was impersonal and avoided use of pronouns (see section 6.2.1). Equally, the Level 3 students included a high number of photographs that contained human participants. By this means they situated themselves on-site, stressing their developing identity as a carpenter; this is congruent with the way they included themselves in their writing by the use of personal pronouns. Seldom, however, did the photographs including human participants constitute 'demand' images, i.e. images where the human participants make eye contact with the viewer. Instead they were depicted as an expected and unremarkable part of the building site.

clutch standard procedure square ignition
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

6.5 Summary of chapter

This chapter has reported the findings of five studies. Firstly, in our study of students' writing of the Builders' Diary, we found a developmental change in the stylistic features of the writing of Level 3 students compared to Level 4 students (6.2.1). Writing changed from personal narrative writing to concise impersonal writing. Secondly, our 'move' analysis of the Builders' Diary (6.2.2) described three important meanings/moves: those describing the context of the building work, those describing the tools and materials used in the building work, and those describing the building work itself. Thirdly, this chapter described a study of the analogies tutors use in classroom teaching (6.3), commenting on their value in linking concrete and abstract conceptualisations. Fourthly, the chapter considered how visual meaning is used in course material in the trades to scaffold understanding of concepts and to guide students to an understanding of more abstract representation of information (6.4.1). Finally, section 6.4.2 considered student use of visual meaning, noting that writers often express the same meaning in words and images.

Chapter 7
Outcomes of the project

Chapter 7: Outcomes of the project

Objective 5 of this study points the way to a key outcome: the development of a range of teaching and learning resources which draw on our research. As a group, our research team includes applied linguists/English language teachers, as well as a literacy specialist, an engineering physics educator and a trades tutor. For all of us, the application of research in practice is important. This chapter reports on the resources we have developed to date. Table 7.1 outlines the resources, and links them to the objectives of the projects as discussed in Chapter 1.

Table 7.1: ***Teaching and learning resources and how they realise the project objectives***

Objectives	How does this objective link to the resources?
Objective 1: To identify the vocabulary of trades-specific texts, whether spoken or written.	The resource outcome of this objective is the development of technical vocabulary lists for each of the 4 trades. The teaching and learning resources, including the 60-second solutions, have been developed to support tutors to embed the teaching of the vocabulary lists as part of their normal practice through specific, identified teaching strategies.
Objective 2: To identify organisation & discourse patterns of spoken and written texts.	The resource outcome of this objective is the identification of 8 key teaching strategies that trades tutors are able to use successfully to embed the teaching of trade-specific language into their teaching. These strategies are being showcased in videos, posters and a guide for organisations. A series of workshops have also been developed for organisations to provide professional development for their tutors to build their practice.
Objective 3: Investigate expression of visual meaning (graphs & diagrams) in trades texts.	The resource outcome of this objective is the development of a guide to interpreting engineering drawings for learners. Included in the series of writing resources for the Builders' Diary is a resource focused on usual images to create meaning.
Objective 4: To identify the literacy and language demands of trades language, with a specific focus on Pacific learners	The resource outcome of this objective is the development of bilingual word lists (English-Tongan). There is also a video called 'the relationship comes first' which outlines the importance of building a relationship with learners before language learning begins. There is also a video on the use of first language in the trades environment to build understanding and a strategy poster which accompanies the video – this is a professional development resource for tutors.

List of teaching and learning resources	
Objective 5: To develop teaching & learning resources.	Resource 1. Technical vocabulary wordlists in 4 trades 2. Tutor reflection tool to support vocabulary teaching 3. 9 short videos showcasing teaching and learning strategies for tutors, delivered by tutors, to embed language development into their teaching 4. Sample glossaries and guidelines for tutors for developing glossaries 5. A set of teaching and learning resources for writing Builders Diaries and guidelines to use 6. Posters demonstrating teaching strategies for tutor professional development 7. Resources on interpreting engineering drawings and expressing visual meaning for learners 8. Bilingual English-Tongan wordlists 9. Professional development resources for tutors teaching in Pasifika trades programmes including 2x videos, 1x poster 10. A complete guide for organisations; *Working around the words: unpacking language learning in vocational training*, which pulls together the resources and offers guidelines for organisations to build tutor capability in embedding language development in trades programmes

A second important outcome of the project is changes in practice. This is difficult for researchers to ensure, as it depends on others (tutors and managers of the institution). In addition, such change happens gradually and it may be too soon to see some of the change that may result. Nevertheless we report on change to date.

We report too on the impact of the research collaboration on the team members. Working closely together across two institutions for more than three years has had some positive outcomes, including research outcomes, professional development in the area of research and teaching, and closer ties to colleagues outside the project both domestically and internationally. Finally, we briefly list our research outcomes, which have been described in chapters 5 and 6 above.

7.1 Resource development

A key finding in the research was the use of the apprenticeship approach in teaching and learning, where language is learnt through practice. This practice has underpinned and shaped the resources that have been designed and development in response to this project. These

resources include a series of focused on 'learning through practice' strategies and activities; posters outlining and exemplifying these points; resources to embed writing development through the practice of diary writing; a tutor vocabulary reflection tool to embed vocabulary development in talk; and finally, the development of four trades word lists based on the concept of word frequency and the use of language in trades training. We consider each of these resources in turn below.

The videos reflect the approach we are advocating as a result of this project and how we see the teaching and learning taking place, supporting the tutors to support the learners in using these resources. The resources move away from extensive written instructions and resources needing to be prepared, as often tutors do not have the time for this. The videos are short, based on tutors talking about what they already do, accompanied by visual imagery and animation. They are underpinned by the key strategies observed in the language learning that takes place in trades training including noticing, drawing attention, eliciting, prompting and building on what learners already know. Each involves a tutor talking about what they do to embed language development and visual imagery and animation to demonstrate key strategies. The strategies are linked to activities to use with learners that are aligned with and can be integrated with the teaching practice and require no preparation. A key strength of this resource is that it builds on and enhances what the tutors are already doing and is shaped by the context in which the resource will be used, a context rich with tutor and learner talk and practical learning.

The videos are recordings of the trades tutors themselves talking about what they are already doing. Therefore, the approach is based on trades tutors teaching other trades tutors what they do in terms of embedding language. Tutors need these resources because they put the tutors themselves at the forefront, leading other tutors in terms of embedding literacy into their teaching. Also, because the recordings are based on strategies for time-poor tutors, they do not require extensive preparation and use of additional resources. We are yet to see the responses from students, but the trades tutors who developed the videos were very positive about the strategies they use, their effectiveness and their keenness to share them with others. What we hope to see are vocational tutors using these videos and then adding to them to build their practice and share their practice of embedding language development with others.

The posters likewise build on learning through practice. The posters are short and simple, with visual imagery and quotes from learners and tutors. They will be displayed throughout the workshops and staff areas. The purpose of these is for tutors to be able to simply glance at these, as they would at a piece of text such as the Gib Site Guide (2014), either to remind them of an activity or strategy, or find a new one, that they can use in their teaching at that moment. They can refer to these continually during the practice of teaching, whether in the workshop or the classrooms. Equally, in the carpentry context, they can be displayed in the houses themselves, once they are weather-tight. Again, because the posters will have quotes from both tutors and learners, they exemplify and build on what tutors and learners are already doing.

The Builders' Diary resources were put together in response to a number of key factors. Firstly, tutors talked about assuming that the learners were able to write clearly and accurately and then finding that many of them could not write to the standard required by the diaries and the learners needed support. Secondly, there are a number of 'moves' which have been identified in the research that learners need to use in the diary writing (section 6.2.2; Parkinson et al., in press), as well as diagrams and pictures (section 6.4.2; Parkinson et al., in review). Thirdly,

in New Zealand there is a requirement for writing to be embedded in Level 3 programmes. Developing resources for diary writing was one way to address these three factors. Traditionally, the practice of diary writing has happened independently and outside of class. Developing embedded classroom resources for writing the diaries is one way of focusing on writing in the classroom and supporting learners in their literacy development.

The Builders' Diary resources were designed with input from the tutors and based on analysis of model diaries previously completed by carpentry learners and the moves identified within these. This meant that the texts being used were written by the learners themselves, and included the moves they had used successfully. The purpose of each writing task was designed in response to the learning needs of the learners, either expressed by the tutors or evidenced in the diaries themselves. There were a number of criteria that the resources needed to meet if they were to be useful for the tutors. Firstly, they needed to be aligned with the context of the building of the house, so if learners were 'setting out and levelling' (i.e. the start of the processes of building the house), the initial resource needed to use this context for developing the writing. Secondly, the writing activity could not take more than 30 minutes as the tutors had little time to spend on writing each week, one hour at the most, and so time needed to be left to write the diary itself. Also, the priority and key motivating factor for the majority of learners is to build the house, so there is a keenness to leave the theory classroom, where the diary writing is taking place, at the earliest opportunity. Thirdly, the resource itself needed to be clear and straightforward. Vocational tutors often have to grapple with the complexities of language and literacy development and the difficulties of embedding this into vocational training (Bak & O'Maley, 2015), so it was important that the resources helped this process rather than make the embedding itself more complex. Finally, as the programme is 34 weeks long and learners are writing diaries throughout this time, it was also important for each resource to be flexible so it could be recontextualised into different contexts of building a house when a particular aspect of writing needed to be focused on, be it note-taking, referencing, punctuation or one of the moves identified.

Each writing task references a different strand of the writing progression of the learning progressions framework. Examples include identifying what the purpose of their diary is and the audience; identifying and using specialised vocabulary; building more complex sentences structures through linking and adding clauses; and revising and editing their writing. In addition, each resource is scaffolded based on an 'into, through and beyond' model, where learners firstly familiarise themselves with the ideas in the task and draw on prior knowledge. This is followed by learners focusing on and practising some aspect of the writing. The task concludes with learners either reviewing a previous diary entry and applying what they have learnt, or by applying what they have learnt to the next entry. For example, a task focused on punctuation was trialled and once learners had completed this, they returned to previous diary entries and edited and reviewed what they had written in terms of how they had punctuated their sentences. The resources as a whole also create a framework where learners begin by focusing on an overview of what a diary looks like, and the key 'moves' they need to consider, then through to resources focused on note-taking and building on their moves, through to editing and proof-reading their writing and finally evaluating their writing and each other's. These diary resources are being re-contextualised in other trades and programmes to support literacy development.

The *Tutor Reflection Tool* has been developed to support embedding of the vocabulary in talk. Because the research showed that the primary way that vocabulary is taught and learnt

is through tutor-talk and tutor-learner interaction around the practical tasks, a tool that recognised and supported this needed to be developed. Although a range of vocabulary activities to support vocabulary learning could have been developed, as the focus is on the practical and learning by doing, it is highly likely that these would be less utilised than developing a tool that supports tutors in what they currently do. The purpose of the reflection tool is to help experienced tutors extend their practice of already drawing attention to the words they use to help learners notice and use them and help tutors new to the programme start developing their practice in terms of embedding vocabulary teaching and learning in tutor talk and tutor-learner interaction. The reflection tool has deliberately been kept simple to ensure it does not complicate what the tutors are already doing. In addition, it articulates and develops what tutors and learners are already doing as they learn the language through practice.

Four trades lists have been developed (see section 5.2), one for each of the four trades of carpentry, plumbing, automotive technology and fabrication. These were developed from corpora of written texts that the learners need to read and understand. These lists are underpinned by the concept that if a word occurs frequently, and learners meet it often, then this is a useful and important word for learners to understand. In addition, learners also mentioned how useful they find the glossaries; however, the current glossaries do not appear to have been designed in relation to how useful a term may be, or whether it even, in fact, appears in the text it accompanies. These lists can be used as a source for developing and updating glossaries for learners based on frequency, for learners to develop their own glossaries and for identifying specialised words in reading texts with the learners and drawing their attention to the words as they meet them in the course texts.

"The purpose of the reflection tool is to help experienced tutors extend their practice of already drawing attention to the words they use to help learners notice and use them and help tutors new to the programme start developing their practice..."

Working around the words – unpacking language learning in vocational training is a guide that has been developed based on what tutors and learners say about language learning; it brings together all the resources developed as a result of this project. The guide is designed to be a 'how to' guide for tertiary organisations to embed language in their trades courses. The book includes a framework for organisations to identify where they are at in a continuum of embedding language in their trades courses. It includes key concepts that the resources have been based on, a framework for tutor development in terms of embedding language and a guide for how to use and build on the resources that have been developed. These guidelines illustrate the way that the resources can be used for staff development purposes (including workshop plans) as well as some broader approaches that organisations may wish to take when focusing on building the capability of their teaching staff to embed language development

into their teaching. Therefore, we hope that this guide can be used by organisations, with initial support, to build their capacity for embedding language development in vocational training.

7.2 Changes in practice

There have been a number of key changes in practice in response to resources already developed and in use. These relate to the writing resources for the diaries, the Tutor Reflection Tool and the vocabulary lists. When carpentry diaries were first introduced into the carpentry programme, the idea was that the learners would complete these in their own time. They would then become a record of the work the learners had completed, be presented to future employers and be used as an additional source of evidence for assessment. However, it soon became apparent that many learners struggled with writing their diary to the required standard and often either wrote short and inaccurate entries, with many key details missing, or avoided writing their diary altogether. As a result of the resource development for the diaries, a range of tutors are spending time focusing on diary writing in class and this can range from initial sessions during the first four weeks of the programme through to one hour a week for the whole 34 weeks. This means there is a greater focus on embedding literacy work into content teaching, an NZQA requirement in Level 1 to Level 3 programmes.

As learners move to online portfolios, the diaries have been adapted to support the literacy in this context. In addition, the diary resources are being used as exemplars to develop writing resources for learners attending level 2 trades programmes that introduce the learners to the building process, as well as the other three trades. Tutors will simply replace the sample texts used in the current resources with samples that would be expected at level 2. This is key as completion of the level 2 trades programme includes achieving the level 1 literacy and numeracy standards in order for learners to gain their Level 2 NCEA. The diary resources can be used to help learners develop their literacy and numeracy and achieve these standards.

Another key change in practice can be better described as enhancing practice. As the research shows, tutors are already drawing attention to the specialised words of carpentry and both tutors and learners emphasise *doing the work around the words*. *The Tutor Reflection Tool* supports this by helping tutors prepare prior to teaching and think about the words they will need to draw attention to during talk and practical work and then reflect after the teaching session on how well they feel the embedding of the vocabulary worked and what could be improved for the next delivery. This tool is also being used in workshops with other tutors to support their embedding of vocabulary development in vocational training.

Finally, the trades vocabulary lists are being used in a number of ways. For example, in carpentry, learners now complete their diary online, as part of a portfolio, and the programme has been divided into 23 topics, each of which has a space for learners to write their diary. In each of the 23 topics, the most frequent words can appear within each topic, to draw learners' attention to these words so they can use them in their diaries and understanding them as part of the topic. Sample glossaries have been developed and these will be added to by the learners and tutors.

In the case of plumbing, one of the Wellington Institute of Technology plumbing tutors is developing a 'one stop' online glossary for the whole sector to use, that underpins Level 3 plumbing trades training. He is using the plumbing trades list to inform this development and ensure that the most useful words that learners will need are included in this list. He commented that he found the list very useful in terms of reminding him what words learners

may not know and may need to learn, and words he had not considered for the list. He also commented on the variety of meanings of a word, both everyday and technical meaning - that learners will be faced with if they 'google' a particular term and hence the need for the technical 'plumbing' definition to be included in the glossary.

In automotive technology the first 100 most frequent words of the automotive trade lists has been divided into four topics by one of the tutors and glossaries are being developed for these and in the case of fabrication, the tutors are using these lists to help learners develop their own glossaries.

"In the case of plumbing, one of the Wellington Institute of Technology plumbing tutors is developing a 'one stop' online glossary for the whole sector to use, that underpins Level 3 plumbing trades training."

Finally, all four lists are also being used in the Level 2 trades training class which introduces learners to a range of trades including carpentry, plumbing and engineering. The lists are being used as a basis for activities, to introduce learners to the words they may need to know depending on which trade they choose at Level three. According to the tutor, the learners are very keen to learn what they see as the 'real trade words' of the trade they hope to pursue.

7.3 Impact on team members

Working in a closely collaborative team has been a very valuable aspect of the project to the team members. Because of the wide scope of the research (with both vocabulary and discourse elements being major foci), it would have been impossible for the project to have been done by one person, so the collaborative element was key in its success. This is evident in the authorship of the articles from the project; it is clear from this that we collaborated on the eight studies in the project in smaller teams, and that these smaller teams varied from study to study.

This project has provided professional and research opportunities for development, and capacity building for our team. One of the team members who had never published before has written an article and submitted it to an international journal (Mclaughlin & Parkinson, in review), and has co-authored a now published article in a local journal (Coxhead et al., 2016). The team has grown to include a summer scholar, a Tongan researcher, and this has not only enabled development of a bilingual English-Tongan resource but has also built research capacity in this researcher. This researcher has also co-authored a research article (Coxhead et al., in press), and he also co-presented a paper at the Asia Pacific Language for Specific Purposes and Professional Communication conference in Wellington in April 2017 (see Appendix 1).

Researchers on the project learned much about the Talanoa research methodology and how relationship building is particularly important in research. It made us conscious of the direct way we generally tend to approach research and that cultural approaches in the Pacific need to be taken into account before successful data gathering can take place.

We have also developed research and pedagogical connections with colleagues in domestic and international contexts in the course of this research. For example, the 4th Asia Pacific Language for Specific Purposes and Professional Communication conference, held in Wellington from April 26-28, 2017, highlighted the work of our research team with presentations and a workshop. This conference was attended by colleagues from Samoa, as well as New Zealand-based researchers and educators from a range of higher education institutions. After presentations in local and international conferences, our team members have had enquiries from audience members who were looking for resources and publications based on our research.

The effect of using data to develop resources has also impacted positively on staff members who are not part of the team. We project that many of our resources will also be of value to tutors in institutions other than Wellington Institute of Technology. Our team members have benefitted from the creative environment of working in a team which has generated many research ideas. Finally, using new research methodologies such as Talanoa and developing a greater understanding of the complexity of the vocabulary and discourse of the trades was a rapid and major learning curve for us all.

7.4 Research outcomes

We have a range of research outputs. To date five articles have been published. These are:

Coxhead, A., Demecheleer, M. & McLaughlin, E. (2016). The technical vocabulary of Carpentry: Loads, lists and bearings. *TESOLANZ Journal*, 24, 38-71.

Coxhead, A., Parkinson, J. & Tu'amoheloa, F. (in press). Using Talanoa to develop bilingual word lists of technical vocabulary in the trades.

Parkinson, J., Demecheleer, M. & Mackay, J. (2017). Writing like a builder: Acquiring a professional genre in a pedagogical setting. *English for Specific Purposes, 46*, 29–44.

Parkinson, J. & Mackay J. (2016). Trades talk: The literacy practices of vocational training. *Journal of Vocational Education & Training, 68*(1), 33-50.

Parkinson, J., Mackay, J. & Demecheleer, M. (in press). Situated learning in acquisition of a workplace genre. *Vocations and Learning*. DOI 10.1007/s12186-017-9191-x

In addition a further three articles and a chapter are in review. These are:

Coxhead, A. (in review). Vocabulary in the trades. Chapter in Coxhead, A. *Vocabulary and English for Specific Purposes Research: Quantitative and qualitative perspectives*. In the Routledge Research in English for Specific Purposes Series. Series Editors: Brian Paltridge and Sue Starfield.

Coxhead, A. & Demecheleer, M. (in review). Investigating the technical vocabulary of Plumbing: Using corpus research to support pedagogy.

McLaughlin, E. & Parkinson, J. (in review). 'We learn as we go': Acquiring a technical vocabulary during apprenticeship.

Parkinson, J., Mackay, J. & Demecheleer, M. (in review). Putting yourself into your work: Expression of visual meaning in student technical writing.

Chapter 8 Conclusions, recommendations, limitations and future research

In this section we outline our conclusions and recommendations of our research, as well as considering some of its limitations and possible directions for future research.

8.1 Conclusions of the research

This section outlines the conclusions of each of the studies described in chapters 5 and 6.

8.1.1 Conclusions: Vocabulary load

The vocabulary load analysis in this research suggests that learners in the trades need a substantial vocabulary in English to cope with the written texts in their studies. This vocabulary is around 9,000 word families plus proper nouns, abbreviations, marginal words, and compounds. This coverage suggests that trades-based texts are similar in vocabulary load to academic written texts, novels, and newspapers. Around 5,000 word families plus supplementary lists are needed for 95% coverage of the written texts. At 95%, learners need support with the vocabulary in the text, such as peer or teacher-based support or reference materials such as glossaries to help the learners with the meaning of the words. Our analysis also found that spoken trades texts have a lower vocabulary load than written trades texts. See Coxhead, Demecheleer and McLaughlin (2016) on carpentry, Coxhead and Demelcheleer (under review) on plumbing, and Nation (2006) for more on vocabulary load analyses of written texts.

8.1.2 Conclusions: Pedagogical word lists

The development of the pedagogical word lists in this study has shown that there is a specialised or technical vocabulary for each of the trades, and that in the written trades texts, as many as one word in three is technical in nature. The spoken trades texts also contain technical vocabulary but not to the same extent as the written texts. The proportion of general to technical vocabulary in spoken trades texts is more like one word in ten.

Another important conclusion is that technical vocabulary contains high frequency items that have a general meaning as well as a technical meaning in the trades. Also, the pedagogical word list research has also shown that abbreviations and proper nouns play an important role in trades texts.

8.1.3 Conclusions: Multi-word units in the trades

The research on multi-word units has shown that there are a substantial (over 1,000) multi-word units in carpentry and a large number even in a small text on diesel engines. These units are important because they are technical in nature and are key units of meaning in the trades. We have identified technical multi-word units in carpentry, which will form a new list for learners and teachers to use in their programmes. We have identified multi-word units in automotive technology, and this analysis will continue, along with analysis in the two other trades.

8.1.4 Conclusions: Research on bilingual word lists

This research has shown that a high number of technical words in the trades have no equivalent in Tongan. This is partly an expected feature of translation in general, and partly because the

words, being technical in nature are quite new words even in English. The fact that vocational education is taught in English in Tonga may play a part in decreasing the likelihood of lexicalisation.

One contribution of this research is the documentation of Tongan in the technical domain. This is important for the vitality of any language (C. Baker, 2006). A second important contribution of this research is for teaching purposes. The bilingual word lists will be useful to trainees in Tonga, and also to Tongan trainees in New Zealand and Australia. Our Tongan informants in New Zealand reported on the difficulties they had experienced in learning the technical language of their trade in English when they first came to New Zealand. They reported that a bilingual technical word list would be useful to Tongan migrants. The Tonga-based trades instructors also viewed the bilingual list as likely to be useful in their teaching. A third contribution is that it gives the Tongan language a presence in educational institutions.

8.1.5 Conclusions: Vocabulary learning in carpentry

It appears that vocabulary is learnt in a variety of ways in the carpentry context, the key one being through tutors and learners drawing attention to the specialised words in tutor talk and tutor-learner interaction. This research has identified additional ways that vocabulary is learnt including using glossaries and drawing pictures. Therefore, it appears that language is a thread woven through the teaching and learning of carpentry, where attention is drawn to the specialised words, integrating this language focus with the learning of the trade.

8.1.6 Conclusions: The literacy demands of trades study

Findings were that being able to engage in appropriate trade talk is an important part of expression of trade identity. Trades professionals need to be able to move between registers in talking the technical trades talk with colleagues and adjusting this to less technical language when talking to clients. The reading that trades students do is extensive and draws on a range of pedagogical, legal and technical documents. Texts are multimodal, with written text embedded with a wide range of visual elements. Trades students do a range of writing including tests, assignments, and professional genres such as the Builders' Diary.

8.1.7 Conclusions: The Builders' Diary: Stylistic and move analysis

Stylistic features

Our findings suggest a trend for carpentry students to move from a personal narrative style at the start of their carpentry studies to a more concise impersonal style later on when they go into employment. At the start of their training, while still on campus, students 'put themselves into' their dairies, and represent themselves as the 'doers' of the building work. This can be seen as building an identity as a carpenter. Once they are in employment, their writing becomes much less personal and more concise. At this stage, situated as they are in the workplace and in their trade and its values, there is less need for them to assert an identity as a carpenter, because they are much closer to being a professional carpenter. In Lave and Wenger's (1999) terms they have moved from peripheral to central participation in their trade.

Because the Builders' Diary is not assessed for itself, but is rather used to assess unit standards, this stylistic change is not likely to be a result of tutor requirements as much as a change in context and perspective. These stylistic changes accompany a physical and psychological

change to a new context. Different contexts have different needs. Novice trainees are learning new knowledge and have the need to record more detail so they can use it later. The writing may also be part of the learning process: a rehearsal of what was experienced on the building site. Level 4 students by contrast have processed and internalised this knowledge; they no longer need to write at such length. Like that of the on-campus writers, the Level 4 writing, too, is a record; but this record is moving from supporting future performance of a task, to supporting memory for billing purposes or, in some remote contingencies, for legal purposes.

Move analysis

Three moves (Move 1, Setting the context of the building work; Move 2, Detailing materials and equipment; Move 4, Detailing building work) are the most frequent moves in the Builders' Diary. They occur in all or almost all the diary extracts we analysed and make up 98.9% of the words in the dataset analysed. They can each be achieved by writers through the use of several strategies. These moves and the strategies used to realise them show how the Builders' Diaries written by carpentry trainees focus on explaining what they did on the building site, how, why and when they did it, and the measurements, materials and tools they used to do it. These three moves reflect the purposes, as mentioned by our carpentry tutor informants, of recording information for future reference and for assessment of unit standards.

8.1.8 Analogies in trades teaching

Our investigation of analogies used by tutors showed a strong feeling of 'apprenticeship in teaching'. Some analogies used are passed on from tutor to tutor and were originally remembered from the tutors own training. This has produced some pride in the use of analogies and in addition, tutors in automotive technology, fabrication and electrical technology see analogies as useful tools in the classroom. A number of tutors generate their own analogies but when this happens, there is sometimes inadequate mapping of relations from the base to the target domain. This is particularly true of the anthropomorphic analogies generated. When tutors have generated non-anthropomorphic analogies, the mapping is good, which makes the analogy robust. Analogical extensions are fairly common with tutors inventing additions to existing common analogies. Most analogies we came across were analogies of electrical concepts. It was evident that on occasion, the way in which electrical analogies were being used could lead to misconceptions amongst the learners and that there are weaknesses and strengths in the two different common analogies used for electrical concepts that appeared not to be recognised by the tutors. From observation of tutors using analogies as part of their teaching however, it was evident that the way tutors preferred to use analogies was as part of a suite of other representations of a concept.

8.1.9 Conclusions: Visual expression of meaning

Visual expression of meaning in course material

This investigation found that trades texts have a high density of visual elements on average. A range of visual elements were found in the texts. Their use varied from trade to trade with photographs being more common in carpentry and in fabrication. The most commonly used visual elements used were drawings. Photographs were used to represent procedures or processes and consequently, many photographs included people. Two connections between images were identified. The first was a temporal connection where a group of images formed a sequence in time and the second was functional, where images were grouped according

to function, for a classificatory purpose. The use of multiple representations in the trades investigated is extensive, but is limited to certain types of representation. The most common is the representation of artefacts obliquely, for identification purposes and also as section views to develop understanding. The use of multiple representations in developing conceptual knowledge in the classroom, as well as the direct teaching of the production of multiple representations, are features of trades teaching that were investigated as well.

Visual expression of meaning in student writing

The use of images as well as language used in the diary, which we have suggested expresses a personal identity as a carpenter, is one conclusion that can be drawn from this study. Secondly, when they depict human participants in the images, the diaries largely depict them as an unremarkable part of the building site, not as the focus of the photograph. Instead the focus of the photographs is very largely the building work rather than the builders themselves. Thirdly, the regularities in expression of visual meaning by the writers of the Builders' Diaries provides evidence that the students, who have no formal training in drawing or photography, share cultural understandings of expression of visual meaning and are, moreover, able to use these understandings to express meaning.

8.2 Recommendations of the research

In this section we outline our recommendations for each of our studies in chapters 5 and 6. We include suggestions for classroom use of our findings.

8.2.1 Recommendations: Vocabulary load

Our findings are important for trades tutors, students, and ESOL tutors, because this research shows that a large vocabulary is needed to cope with reading in the trades. Written trade texts contain a large amount of technical vocabulary. While a great deal of trades education is spoken in nature, learners need exposure to written trades texts as well in order to be exposed more to the technical trades vocabulary. At 95% coverage, learners need around 5,000 word families and support for their reading. As learners need a large vocabulary to understand their course materials, we recommend testing their vocabulary at the beginning of their study to see how much support they need in reading their texts. The vocabulary load of spoken trades texts is lower than the written trades texts, and learners in the trades are faced with a large amount of listening in their studies (Coxhead et al., 2016). This research suggests that learners need a large vocabulary to be able to cope with reading, in particular, in their studies. As the research showed, there is a need to be able to 'walk and talk' like a builder, expressed by both the tutors and the learners. Therefore, ways that embed vocabulary into existing teaching and learning, so that the learning of the language is integrated with the learning of the vocational content, could help support learners to be able to cope with the vocabulary.

8.2.2 Recommendations: Pedagogical word lists

The research on pedagogical word lists uncovered a large number of technical words in high frequency vocabulary in English. Learners need to be made aware of the technical meanings of these words early on in their studies. It cannot be taken for granted that learners know the technical meaning of everyday words in the trades. First and second language speakers of English need support for the development of this lexis. Developing skills in recognising technical words in speaking and in writing is important for all learners in the trades. Table 8.1 contains

suggestions on how learners might deal with technical vocabulary for learners with a Tongan background, but many of the suggestions can be adapted for English as a first language learners and for speakers of other languages as well.

We recommend that Nation's (2013) framework of planning, strategy training, testing, and teaching vocabulary are taken up by trades as well as ESOL tutors in Institutes of Technology and polytechnics. These four parts of the framework are listed by Nation in order of importance, with planning for vocabulary at the top of the list. The pedagogical word list and the abbreviations and proper noun lists could be used in planning to help identify lexical items which will need attention during a course of study. Planning could also include aspects of word knowledge (Nation, 2013) including, for example, how the words are written, how they sound, their meanings, and common word patterns. Planning also needs to take into account the time frames of courses and the time that learners have for vocabulary in busy educational programmes. Vocabulary development, particularly the technical vocabulary of a trade, should not be left to chance. The second aspect of Nation's framework is ensuring that learners in the trades have strategy training on how to learn technical vocabulary effectively and efficiently. The third aspect is testing. It is important that vocabulary becomes part of the learning objectives of trades courses and therefore that it is assessed during these courses. Finally, teaching is an important part of the framework, but it needs to be the last part. Vocabulary needs to be taught, but should be done once all the planning, strategy training, and testing elements are already in place. See Coxhead and Demecheleer (under review) for more on using Nation's (2013) framework with vocabulary in the trades.

"We recommend that Nation's (2013) framework of planning, strategy training, testing, and teaching vocabulary are taken up by trades as well as ESOL tutors in Institutes of technology and polytechnics."

8.2.3 Recommendations: Multi-word units in the trades

This research is ongoing but at this early stage, we recommend that teachers and learners use the resulting multi-word lists in much the same guiding way as the single-word lists. That is, we suggest using these lists as guides for planning for courses, as well as strategy training, testing, and teaching, drawing on Nation's (2013) framework.

8.2.4 Recommendations: Research on bilingual word lists

To support learning in New Zealand trades training, we recommend supplying these bilingual lists for students for whom Tongan is a first language.

As trades instructors, the Tongan-based informants had a number of suggestions to extend the bilingual trades lists including the development of a bilingual technical dictionary including the English and Tongan terms, the Tongan and English definitions, and diagrams illustrating the vocabulary item. It was also suggested that textbooks be reprinted with the addition of the technical vocabulary as a glossary.

Table 8.1 on the following page is taken from Coxhead et al. (in press) and focuses on categories of technical vocabulary in Tongan and their features. It also presented suggestions on what support learners need to help with learning these words in English.

8.2.5 Recommendations: Vocabulary learning in carpentry

In order to support what the tutors are already doing when teaching the vocabulary, we recommend building on the approach of learning through practice and drawing attention to the vocabulary used in talk. This could be through developing a tool where tutors can plan for their teaching, and the words that may arise, and reflect on strategies they used and whether their learners are understanding and using the new words. In addition, work could also be undertaken to update the glossaries and develop these further, using the pedagogical word lists as a source to draw on, as the glossaries are a resource that the learners have mentioned using. Support could also be put in place to help tutors develop glossaries using the word lists, as well as a range of simple activities and teaching strategies tutors can use to further integrate and support the learning of vocabulary while learning the trade. This would help learners to meet the national literacy benchmark of being able to understand and use more specialised words.

8.2.6 Recommendations: The literacy demands of trades study

Further research is needed into reading in the trades, which is demanding and varied, as well as into informal talk by students assisting in integrating known and new information.

Table 8.1: *Features of technical vocabulary in Tongan and suggestions for learning (from Coxhead, Parkinson & Tu'amoheloa, in press)*

Category	Features of these words	The learners need
Words with Tongan equivalents	Might be everyday words with technical meanings in the trades; many lexical items are in this category	Exposure to the technical meanings of everyday words in the trades context; understanding that there are many technical words in the trades which have equivalents in Tongan, so learners can draw on that knowledge in their first language
Tonganised words	Have Tongan spelling and pronunciation; are likely to be high frequency words	Recognise spelling patterns in words borrowed from English and use these patterns to focus on the Tonganised words in English; focus on how these words are pronounced in English
Loan words	Known in the spoken form; possibly not known in the written form	Exposure to the written form and practice recognising the spoken form in English
Words with no single word equivalent in Tongan	Are likely to be lower frequency technical words in the trades; neither the technical meaning nor the word is likely to be known by the learner	Ensure there is repetition in the learning to help remember the words; ensure there are opportunities to use these words in writing as well as encounter them in listening and reading; use strategies such as word cards to keep track of the words and learn them directly
Words which are translated into a number of synonyms	The word in Tongan covers the same meaning, but the English words might have slightly different meanings; collocations for the synonyms might be different in the trades context	Focus on the meaning and form of the most frequent synonym first, and then work on the less frequent synonyms when they appear in the trades texts; check collocations of the words in trades texts to see if there is a difference (for example, what words are commonly used with *apparatus* and which words are commonly used with *equipment*?

8.2.7 Recommendations: The Builders' Diary: Stylistic and move analysis

Stylistic features

Changes in stylistic features of student diary writing are developmental, with early personal narrative-style writing playing a role in identity development in which students 'put themselves into their writing'. Therefore our recommendations are that explicit teaching of the

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

> **"We recommend that at the point at which students move into the workplace, time could be spent on showing the students the two styles of writing, and representing the benefit of the more concise less personal telegraph point-form style"**

developmentally later concise telegraphic style is not necessary. We recommend that at the point at which students move into the workplace, time could be spent on showing the students the two styles of writing, and representing the benefit of the more concise less personal telegraph point-form style. Students could be made aware of the stylistic and grammatical features associated with both styles and could be asked to rewrite a narrative personal diary entry in the concise telegraphic style. This would enhance awareness of these stylistic features and facilitate conciseness in writing.

Move analysis

Recommendations based on our move analysis are the use by carpentry tutors of our move analysis in initial teaching of the Builders' Diary. Table 6.4 shows examples of each of the frequent strategies within moves. These are examples of the kinds of information that students need to include in the diaries. Appendix 10 shows a sample diary entry which has been analysed using our move analysis. This too can be used as an example showing how to write the diary. In teaching using a move analysis, it is important not to teach writing of the diary as a 'recipe' that is unchanging, but rather to discuss the varied purposes of the diary (as outlined in section 6.2) that is flexible and can change according to context and according to the needs of writers. Our analysis showed some developmental change in moves used as writers moved from the on-campus setting to the workplace.

Diaries themselves can be used as a source to embed the teaching and learning of the various moves highlighted in the research. We found that learners are often directed to complete their diaries outside of class, and as a consequence, many diaries are left unfinished or not undertaken Our resources suggest using models of student diaries as a resource and then embedding scaffolded tasks into regular classes in which learners develop the skills to write their diaries. Within the constraints of the teaching and learning environment where the focus is on building the house, this could support the development of student writing, and their ability to use the various moves. The tasks could be aligned with and draw on the writing strand of the Learning Progressions for Adult Literacy (TEC, 2008), developing, for example, the ability to plan and compose their diary entries, review and edit them for meaning and sense in terms of purpose and audience, and use more specialised words, such as carpentry terminology, accurately.

8.2.8 Recommendations: Analogies in trades teaching

Analogies in the electrically related trades especially are an important tool in the tutors' toolbox. However the choice of electrical analogy can affect the conceptual development of

the learners. Therefore, when tutors further develop existing analogies or develop their own analogies, we recommend that care be taken to ensure that the mapping of both attributes and relations is adequate.

8.2.9 Recommendations: Visual expression of meaning

Course materials

The use of multiple representations in trades teaching and in the learning support material the tutors create is extensive. We recommend deliberate exposure of students to multiple representations of concepts.

Student writing

The regularities in expression of meaning, most notably of left-right organisation of image and text, of image-image relations, and of image-text relations, suggest the usefulness of explicitly addressing expression of visual meaning in teaching the Builders' Diary. We recommend showing students examples of how temporal, spatial and overview-detail image-image relations have been expressed. Similarly a discussion of the value of a certain degree of redundancy between the visual and written mode would be useful.

8.3 Limitations of the research and directions for future research

In this section we note limitations of our research, and point the direction for further studies.

8.3.1 Limitations/future research: Vocabulary load

There are several limitations of the vocabulary load research. Firstly, the size of the written and spoken corpora for the trades was limited because of the decision to include only texts used at the institution where this project was based. This limitation is important because it affects the generalisability of the research findings. Secondly, using Nation's BNC COCA (2016) lists is also a limitation because the original BNC corpus is built from mostly written texts rather than spoken, and on British texts (see Nation, 2004). More research is needed on vocabulary load and the spoken texts in the trades corpora.

8.3.2 Limitations/future research: Pedagogical word lists

Like the vocabulary load study, the size of the corpora in this study are a limitation of the results, and affects the generalisability of the findings. Developing larger corpora from different educational sites would help with validation of this study. Another limitation is that the number of tutors involved in the ranking of technical vocabulary was quite small. The process of identifying technical vocabulary involves cut off scores for frequency in the trades corpora, and inevitably, these cut off scores weed out potential candidates for a word list. It is important that users understand how these word lists were made and the decisions that were made in their development, because these aspects of word list building affect the final lists.

More research is needed on the items in these pedagogical word lists in the trades. One possible area of research is to develop a second corpus of written texts in each trade and find out whether the same words would be identified in that analysis (Miller & Biber, 2015). This validation process would also serve as a replication, which is always an important element of research. Another area of research is to more fully investigate the spoken trades corpora, to

find out whether these word lists based on written corpora really represent the vocabulary of tutor talk in the trades. Coxhead (under review, b), for example, looks at academic vocabulary in written texts and teacher talk in an international school context. Similar research could be carried out in the trades context. It would be useful to consider whether there is a common vocabulary of carpentry and plumbing as construction trades, and automotive technology and fabrication as engineering trades, or whether these groups actually have quite different technical lexis.

8.3.3 Limitations/future research: Multi-word units

A limitation is that the multi-word unit analysis is also affected by the size of the written corpora. As mentioned above, more research is needed in the multi-word units of the trades, drawing on our existing work on the written carpentry corpus and moving on to completing the automotive technology work, and then on to the other two trades. This research needs to be extended to other trades outside the four in this research project. It could also be extended into the translations of multi-word units into languages such as MĐori, Samoan, Tongan, and Fijian. If trades education is based in other languages, then our research can serve as a way to carry out this same research in other languages. It is vital that trades vocabulary research does not stop with this study in English, but continues in other languages, in other trades, and in other countries.

8.3.4 Limitations/future research: Research on bilingual word lists

One limitation of the bilingual word lists research relates to the lack of formal expertise in translation of both the researchers and the participants in the study. This is consequent on the fact that both specialised trades knowledge and mother tongue proficiency in Tongan was required of the participants who did the translation, and specialists in the trades are unlikely to be trained translators.

A further limitation is that this work focused only on the Tongan language. Further research to expand these bilingual word lists into other Pacific languages, including Samoan and Fijian, would ensure that students from all Pacific communities would benefit.

8.3.5 Limitations/future research: Vocabulary learning in carpentry

One limitation of the research is that it focused on the learning of vocabulary in one trade, carpentry. Therefore it would be useful to extend this work into other trades. This could provide directions for use of the trades vocabulary lists in these areas. Also, the analysis was limited to the work of four experienced tutors, 15 hours of recordings and the Level 3 programme. Exploring programmes at other levels, or with less experienced tutors, new to vocational teaching but experienced in their trade, could highlight different practices, as could interviews with other tutors and learners, which in turn could be used to support language development in this trade.

8.3.6 Limitations/future research: The literacy demands of trades study

A limitation of our study was that we have not yet investigated spoken literacy events, such as informal talk between students in automotive technology. In addition, further investigation of the reading demands of trades study would be useful, as reading demanded of trades students is extensive, technical, and demanding.

diameter terminal sensor measuring regulations carpentry sensor clamping valve assessment trap carpentry level section

8.3.7 Limitations/future research: The Builders' Diary: Stylistic and move analysis

Stylistic features

A limitation of this aspect of our analysis was our inability to interview writers of diaries about their writing, because the analysis took place after students had left the institution. The students' process in writing the diaries is a worthwhile direction for future research. In addition, it would have been good if we had been able to source diaries of carpentry professionals; however for confidentiality reasons we were unable to do so. This is another direction for future research.

Move analysis

Limitations of this analysis are the small data set we used. In addition, we were not able to interview the writers of the diaries, because the diaries were collected two years before the analysis, and by that time students had left the institution.

"further investigation of the reading demands of trades' study would be useful, as reading demanded of trades students is extensive, technical, and demanding"

8.3.8 Limitations/future research: Analogies in trades teaching

This research was limited by the small sample of tutors available to be interviewed as well as the limited number of analogies recorded. While this was an accurate reflection of the use of analogies in teaching in these trades at one institution, it would be good to collect commonly used as well as self-generated analogies from across New Zealand. There needs to be an expansion of the investigation to look in more detail at ways in which analogies are integrated with other forms of conceptual representation by trades tutors. Lastly, there needs to be an investigation of how trades tutors generate analogies.

8.3.9 Limitations/future research: Visual expression of meaning

Course materials

This research described in section 6.4.1 is limited to the small sample of learning materials analysed as well as the small number of tutors observed in class. Even so, the research found several interesting things about the way in which multiple representations are used in the teaching materials and the way in which visual literacy is developed in the trades. There are several aspects of this study that need to be expanded upon, excluding the need to look at a greater range of trades. The first is that there needs to be a comprehensive investigation of all materials used in each trade and not just a sample. This will clear up some issues around the anomalous use of different visual elements in both plumbing and fabrication. The effect of the texts selected needs to be eliminated and to do this one would need to analyse multiple texts on the same topic. Secondly, this study limited itself to in-text visual elements. However, the trades tutors have a substantial collection of their own visual resources, photographs they have taken, video material of their own and taken from other sources, as well as animations and simulations. To include this is a study on its own, but it should be done.

Student writing

As mentioned previously, limitations of this work were our inability to interview student writers, and our inability to source the diaries of carpentry professionals. Both students' process in writing their diaries as well as the features of professional diaries could form the subject of future research.

References

Ainsworth, S. (2006). DeFT: A conceptual framework for considering learning with multiple representations. *Learning and Instruction*, 16(3), 183-198.

Ardasheva, Y. & Tretter, T.R. (2017). Developing science-specific, technical vocabulary of high school newcomer English learners. *International Journal of Bilingual Education and Bilingualism, 20*(3), 252-271, DOI: 10.1080/13670050.2015.1042356

AT 4210 Heavy Vehicle Hydraulics and Pneumatics Systems 1. (2015). Wellington: Wellington Institute of Technology.

AT 4201 Engine Performance (III). (2009). Wellington: Wellington Institute of Technology.

Atkin, C., Rose, A. & O'Grady, A. (2007). *Evaluation of the DfES materials for embedded learning*. London: National Research and Development Centre for Adult Literacy and Numeracy.

Bak, T. & O'Maley, P. (2015). Towards professional responsibility for language and literacy: exploring vocational teachers' emerging language and literacy understandings and identities. *Literacy and Numeracy Studies, 23*(1), 50-72.

Baker, C. (2006). *Foundations of bilingual education and bilingualism* (Vol. 79). Multilingual matters.

Baker, M. (2011). *In other words: A coursebook on translation*. Routledge.

Baldacchino, G. (2006). Managing the hinterland beyond: Two idealÐtype strategies of economic development for small island territories. *Asia Pacific Viewpoint*, 47(1), 45-60.

Basic Fabrication workbook. (n.d.). Wellington: Wellington Institute of Technology.

Basturkmen, H. (2012). A genre-based investigation of discussion sections of research articles in Dentistry and disciplinary variation. *Journal of English for Academic Purposes, 11*, 134–144.

Basturkmen, H. & Shackleford, N. (2015). How content lecturers help students with language: An observational study of language-related episodes in interaction in first year accounting classrooms. *English for Specific Purposes, 37*, 87-97.

Benseman, J., Sutton, A. & Lander, J. (2005). *Working in the light of evidence, as well as aspiration: A literature review of the best available evidence about effective adult literacy, numeracy and language teaching*. Wellington: Ministry of Education.

Bezemer, J. & Kress, G. (2009). Visualizing English: a social semiotic history of a school subject. *Visual Communication, 8*(3), 247-262.

Biber, D. (2006). *University language*. Amsterdam: John Benjamins.

Biber, D., Connor, U. & Upton, T.A. (2007). *Discourse on the move.* Amsterdam: John Benjamins.

Biewer, C. (2015). *South Pacific Englishes: A Sociolinguistic and Morphosyntactic Profile of Fiji English, Samoan English and Cook Islands English.* John Benjamins.

Bracey, K. & Cross, F. (n.d.). *Action enquiry - Case study from Otago Polytechnic*. Waikato: Wilf Malcolm Institute of Educational Research.

Bruce, I. (2009). Results sections in sociology and organic chemistry articles: A genre analysis. *English for Specific Purposes, 28*(2), 105–124.

Byrd, P. & Coxhead, A. (2010). On the other hand: Lexical bundles in academic writing and in the teaching of EAP. *University of Sydney Papers in TESOL*, 5, 31-64.

clutch standard procedure square ignition carbon
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currnet marking-out

Cameron, M., Hipkins, R., Lander, J. & Whatman, J. (2011). *The Transfer of Literacy, Language, and Numeracy Skills from Learning Programmes into the Workplace*. Wellington: Department of Labour.

Casey, H., Cara, O., Eldred, J., Grief, S., Hodge, R., Ivanič, R., Jupp,T., Lopez, D. & McNeil, B. (2006). *"You wouldn't expect a maths teacher to teach plastering..." Embedding literacy, language and numeracy in post-16 vocational programmes - the impact on learning and achievement*. London: National Research and Development Centre for Adult Literacy and Numeracy.

Chan, S. (2014). Crafting an occupational identity: learning the precepts of craftsmanship through apprenticeship. *Vocations and Learning, 7*(3), 313-330.

Chan, S. (2016). Belonging to a workplace: first-year apprentices' perspectives on factors determining engagement and continuation through apprenticeship. *International Journal for Educational and Vocational Guidance, 16*(1), 9-27.

Chrisp, P. & Reid, S. (2002). *Te Whare Ako (The House of Learning) Case Study*. Auckland: Workbase.

Chung, T. M. & Nation, P. I. (2003). Technical vocabulary in specialised texts. *Reading in a Foreign Language, 15*(2), 103 - 116.

Chung, T. M. & Nation, P. I.S.P. (2004). Identifying technical vocabulary. *System, 32*(2), 251–263.

Cobb, T. (n.d.). *The Compleat Lexical Tutor*. Available at http://www.lextutor.ca/ on 4 April, 2017.

Competenz National Certificate in Machining (level 2) Module 11. (2012). Wellington: Wellington Institute of Technology.

Connor, U. & Mauranen, A. (1999). Linguistic analysis of grant proposals: European Union research grants. *English for Specific Purposes, 18*(1), 47–62.

Cooper, B. & M. Baynham. (2005). *Rites of Passage: Embedding Meaningful Language, Literacy and Numeracy Skills in Skilled Trades Courses through Significant and Transforming Relationships*. London: National Research and Development Centre for Adult Literacy and Numeracy.

Cortes, V. (2004). Lexical bundles in published and student disciplinary writing: Examples from history and biology. *English for Specific Purposes, 23*(4), 397 - 423.

Costa, F. (2012). Focus on form in ICLHE lectures in Italy: Evidence from English-medium science lectures by native speakers of Italian. *AILA Review, 25*(1), 30-47.

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly, 34*(2), 213Ð238.

Coxhead, A. (2017, March). *Formulaic vocabulary in the trades: Applied Linguistics meets Automotive Engineering.* Paper presented at American Association for Applied Linguistics (AAAL) Conference 2017, Portland, Oregon, USA.

Coxhead, A. (in review, a). Vocabulary in the trades. Chapter in Coxhead, A, *Vocabulary and English for Specific Purposes Research: Quantitative and qualitative perspectives*. In the Routledge Research in English for Specific Purposes Series. Series Editors: Brian Paltridge and Sue Starfield.

Coxhead, A. (in review, b). Academic vocabulary in teacher talk: Challenges and opportunities for pedagogy. *Oslo Studies in Language*.

diameter terminal sensor measuring regulations carpentry sensor clamping valve assessment trap carpentry level section

Coxhead, A., Demecheleer, M. & McLaughlin, E. (2016). The technical vocabulary of Carpentry: Loads, lists and bearings. *TESOLANZ Journal*, 24, 38-71.

Coxhead, A. & Demecheleer, M. (in review). A pedagogical word list of Plumbing: Insights from corpora and expert tutors. *English for Specific Purposes.*

Coxhead, A., Parkinson, J. & Tu'amoheloa, F. (in press). Using Talanoa to develop bilingual word lists of technical vocabulary in the trades. *International Journal of Bilingual Education and Bilingualism.*

Coxhead, A., Stevens, L. & Tinkle, J. (2010). *Why might secondary science textbooks be difficult to read?* New Zealand Studies in Applied Linguistics, 16(2), 35-52.

Creese, A. (2006). Is this content-based language teaching? *Linguistics and Education, 16*, 188 - 204.

Edwards, R., Minty, S. & Miller, K. (2013). The literacy practices for assessment in the vocational curriculum – the case of Hospitality. *Journal of Vocational Education and Training, 65*(2), 220-235.

Electrical Technology workbook. (2014). Drawing Diagrams. Wellington: Wellington Institute of Technology.

Ellis, R., Basturkmen, H. & Loewen, S. (2001). Preemptive Focus on Form in the ESL Classroom. *TESOL Quarterly, 35*(3), 407 – 432.

Filliettaz, L. (2010). Interaction and miscommunication in the Swiss vocational education context: Researching vocational learning from a linguistic perspective. *Journal of Applied Linguistics and Professional Practice, 7*(1), 27-50.

Flowerdew, J. & Wan, A. (2010). The linguistic and the contextual in applied genre analysis: The case of the company audit report. *English for Specific purposes, 29*(2), 78-93.

Gentner, D. (1983) Structure-mapping: A theoretical framework for analogy. *Cognitive Science, 7*, 155-170.

Gib site guide. (2014). Winstone Wallboards Ltd.

Gray, A. (2006). *Upskilling through foundation skills: A literature review*. Wellington: Department of Labour.

Halliday, M.A.K. (1978). *Language as social semiotic: The social interpretation of language and meaning.* London: Edward Arnold.

Halliday, M.A.K. (1994). Functional grammar. London: Edward Arnold.

Heatley, A., Nation, I. S. P. & Coxhead, A. (2002). Range [Computer software]. Accessed from http://www.victoria.ac.nz/lals/about/staff/paul-nation#vocab-programs

Hirsh, D. & Coxhead, A. (2009). Ten ways of focussing on science-specific vocabulary in EAP classrooms. *English Australia Journal, 25*(1), 5-16.

Hirsh, D., & Nation, P. (1992). *What vocabulary size is needed to read unsimplified texts for pleasure?* Reading in a Foreign Language, 8, 689-689.

Holmes, J. & Woodhams, J. (2013). *Building interaction: Building interaction: The role of talk in joining a community of practice.* Discourse & Communication, 7(3), 275–298.

ITP Carpentry development consortium. (n.d.). Site Preparation student workbook. Wellington: Wellington Institute of Technology.

Ivanič, R., Edwards, R., Barton, D., Martin-Jones, M., Fowler, Z., Hughes, B., Manion, G., Miller, K., Satchwell, C. & Smith, J. (2009). *Improving Learning in College: Rethinking Literacies across the Curriculum*. London: Routledge.

Jewitt, C. (2002). The move from page to screen: the multimodal reshaping of school English. *Visual Communication*, 1(2), 171-195.

Karlsson, A.M. (2004). How to build a house from reading a drawing: Professional and popular mediations of construction. *Visual Communication*, 3(3), 251-279.

Kell, C., Guy, S., Hastwell, K. & Harvey, S. (2009). *In-House Literacy, Language and Numeracy (LLN) Initiatives in New Zealand Workplaces*. Wellington: Department of Labour.

Kress G.R. & van Leeuwen T. (1996). *Reading images: The grammar of visual design*. London: Routledge.

Lakoff, G. (1993). The Contemporary Theory of Metaphor. In A. Ortony (Ed.), *Metaphor and Thought*, Second Edition. New York: Cambridge University Press.

Latham, T. (2010). Embedding literacy. In N. Hughes, & I. Schwab, *Teaching adult literacy: Principles and practice* (pp. 344-364). Berkshire: NRDC & Open University Press.

Laufer, B. & Ravenhorst-Kalovski, G. C. (2010). Lexical threshold revisited: Lexical text coverage, learners' vocabulary size and reading comprehension. *Reading in a ForeignLanguage, 22*(1), 15.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lave, J. & Wenger, E. (1999). *Legitimate peripheral participation. Learners, learning and assessment*. London: The Open University.

Lea, M. R. & Street, B. V. (2006). The 'Academic Literacies' Model: Theory and Applications. *Theory into Practice, 45*(4): 368–377.

Leach, L., & Zepke, N. (2010). Making it into the pipeline: Transitions from school to tertiary education. *Journal of Adult Learning, 38*(1), 5-22.

Lehmann, W. (2005). Choosing to labour: Structure and agency in school-work transition. *Canadian Journal of Sociology, 30*(3), 325-350.

Lotherington, H. (1998). Trends and tensions in post-colonial language education in the South Pacific. *International Journal of Bilingual Education and Bilingualism*, 1(1), 65-75.

Mackay, J. (2014). *Tracking the understanding of physics ideas in the trades: Trades tutors use of analogies in developing explanations of basic physics ideas.* International Commission on Physics Education Conference. Cordoba, Argentina, August 2014.

Mackay, J. (2015). *The use of multiple representations in teaching "trades physics".* International Commission on Physics Education Conference. Beijing, China, August 2015.

Martin, J.R. (1984) Language Register & Genre. In F. Christie (ed.), *Language Studies: Children Writing. Reader.* Geelong: Deakin University press.

diameter terminal sensor measuring regulations carpentry sensor clamping valve assessment trap carpentry level section

Martin, J. R. (2009). Genre and language learning: A social semiotic perspective. *Linguistics and Education, 20*(1), 10-21.

Maxwell, J. C. (1990). *The Scientific Letters and Papers of James Clerk Maxwell: 1846-1862*, (Vol. 1). CUP Archive.

McLaughlin, E. & Parkinson, J. (in review). *'We learn as we go': Acquiring a technical vocabulary during apprenticeship.*

Miller, C. R. (1984). Genre as social action. *Quarterly Journal of Speech, 70*(2), 151-167.

Miller, D. & Biber, D. (2015). Evaluating reliability in quantitative vocabulary studies: The influence of corpus design and composition. *International Journal of Corpus Linguistics*, 20(1): 30-53.

Ministry of Education. (2009). *Tertiary education strategy 2010-15. Wellington: Ministry of Education*. Accessed on 23 April 2013 from http://www.minedu.govt.nz/NZEducation/EducationPolicies/TertiaryEducation/PolicyAndStrategy/~/media/MinEdu/Files/TheMinistry/TertiaryEducationStrategy2010/TES2010to2015.pdf

Ministry of Education. (2012). *Adult Literacy and Numeracy Implementation Strategy*. Accessed 21 April 2013 from: http://www.tec.govt.nz/Documents/Reports%20and%20other%20documents/Adult-Literacy-and-Numeracy-Strategy.pdf

Mohan, B. A. (1986). *Language and Content*. Reading: Addison-Wesley Publishing Company.

Mudraya, O. (2006). Engineering English: Lexical frequency instruction model. *English for Specific Purposes*, 25(2) 235-256.

Murray, D.E. (2010). Austalasia and the Pacific. In M. Berns (ed.), *The concise encyclopedia of Applied Linguistics* (pp. 37-44). Elsevier.

Nation, I. S. P. (1990). *Teaching and Learning Vocabulary.* New York: Newbury House.

Nation, I.S.P. (2004). A study of the most frequent word families in the British National Corpus. In P. Bogaards and B. Laufer (eds.) *Vocabulary in a Second Language: Selection, Acquisition and Testing* (pp. 3-13). Amsterdam: John Benjamins.

Nation, I.S.P. (2006). How large a vocabulary is needed for reading and listening? *Canadian Modern Language Review, 63*(1), 59-82.

Nation, I.S.P. (2007). Vocabulary Learning through Experience Tasks. *Language Forum, 33*(2), 33-43.

Nation, I. S. P. (2012). *The BNC/COCA word family lists.* Retrieved from http://www.victoria.ac.nz/lals/about/staff/paul-nation

Nation, I. S. P. (2013). *Learning vocabulary in another language* (2nd ed.). Cambridge: Cambridge University Press.

Nation, I. S. P. (2016). *Making and Using Word Lists for Language Learning and Testing*. John Benjamins Publishing Company.

National Certificate in Machining (Level 2) Module 11. (2012). Wellington: Wellington Institute of Technology.

Parkinson, J. (2017). The student laboratory report genre: A genre analysis. *English for Specific Purposes, 45*, 1-13. doi.org/10.1016/j.esp.2016.08.001

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Parkinson, J., Demecheleer, M. & Mackay, J. (2017). Writing like a builder: Acquiring a professional genre in a pedagogical setting. *English for Specific Purposes, 46*, 29–44. doi.org/10.1016/j.esp.2016.12.003.

Parkinson, J. & Mackay J. (2016). Trades talk: The literacy practices of vocational training in Carpentry and Automotive Technology. *Journal of Vocational Education & Training, 68*(1), 33-50.

Parkinson, J. Mackay, J. & Demecheleer, M. (in press). Situated learning in acquisition of a workplace genre. *Vocations and Learning*. DOI 10.1007/s12186-017-9191-x

Parkinson, J. Mackay, J., & Demecheleer, M. (in review). *Putting yourself into your work: Expression of visual meaning in student technical writing.*

Podolefsky, N., Adams, W. and Finkelstein, N. (2004). *Analogical Scaffolding of Abstract Ideas in Physics.* Poster presented at the 2004 American Association of Physics Teachers National Meeting. Sacramento, California.

Roberts, C., Baynham, M., Shrubshall, P., Brittan, J., Cooper, B., Gidley, N., Windsor, V., Eldred, J., Grief.S., Castilino.C. & Walsh, M. (2005). *Embedded teaching and learning of adult literacy, numeracy and ESOL: Seven case studies*. London: NRDC.

Rowley-Jolivet, E. (2004). Different visions, different visuals: A social semiotic analysis of field-specific visual composition in scientific conference presentations. *Visual Communication, 3*(2), 145-175.

Ryan, R., McDonald, H., Sutton, A. & Doyle, S. (2012). *Formative Evaluation of ITO Embedded Literacy and Numeracy Projects*. Wellington: Department of Labour.

Scott, M. (n.d.). WordSmith Tools. Available at http://www.lexically.net/wordsmith/ on 4 April, 2017.

Seufert, T. (2003). Supporting coherence formation in learning from multiple representations. *Learning and Instruction, 13*(2), 227-237.

Sligo, F., Tilley, E., Murray, N., Watson, B., Comrie, M. & Vaccarino, F. (2010). *Modern Apprentices' Literacy Learning: A Formative Evaluation*. Wellington: Department of Labour.

Smith, J., Satchwell, C., Edwards, C. R., Miller, K., Fowler, Z., Gaechter, J., Knowles, J., Phillipson, C. & Young, Y. (2008). Literacy Practices in the Learning Careers of Childcare Students. *Journal of Vocational Education and Training 60*, (4), 363–375.

Statistics New Zealand. (2014). *2013 Census QuickStats about culture and identity.* Accessed 15 March 2017 from www.stats.govt.nz.

Swales, J. (1990). *Genre analysis: English in academic and research settings*. Cambridge University Press.

Taboada, A. (2012). Relationships of General Vocabulary, Science Vocabulary, and Student Questioning with Science Comprehension in Students with Varying Levels of English Proficiency. *Instructional Science 40*(6), 901–923. doi:10.1007/s11251-011-9196-z

Tardy, C. M. (2011). ESP and multi-method approaches to genre analysis. *New directions in English for specific purposes research*, 145-173.

Taufe'ulungaki, A. (1999). The Teaching of Vernacular Languages in the Pacific with Special Reference to Tonga. *Pacific Curriculum Network, 8*(2), 2-4.

Tertiary Education Commission. (2008). *Learning Progressions for Adult Literacy*. Wellington.

Tertiary Education Commision. (2014). *Tertiary Education Strategy*. Wellington.

UCREL. (n.d.). *CLAWS7 Tagset*. Accessed from http://ucrel.lancs.ac.uk/claws7tags.html

Unsworth, L. (1997). Scaffolding Reading of Science Explanations: Accessing the Grammatical and Visual Forms of Specalized Knowledge. *Literacy 31*(3), 30 - 42.

Vaioleti, E.C. & T. Vaioleti, T. (2003). *Cultural motivations for learning*. Paper presented at the Inaugural Pacific Research: Education Symposium, University of Waikato.

Vaioleti, T.M. (2006). Talanoa Research Methodology: A Developing Position on Pacific Research. *Waikato Journal of Education, 12*, 21-34.

van Leeuwen, T. (1991). Conjunctive structure in documentary film and television. Continuum: *Journal of Media & Cultural Studies, 5*(1), 76-114.

Varpio, L., Spafford, M.M., Schryer, C.F. & Lingard, L. (2007). Seeing and listening: A visual and social analysis of optometric record-keeping practices. *Journal of Business and Technical Communication, 21*(4), 343-375.

Vaughan, K., Bonne, L. & Eyre. J. (2015). *Knowing Practice: Vocational Thresholds for GPs, Carpenters, and Engineering Technicians*. Summary Report. New Zealand Council for Educational Research and Ako Aotearoa: Wellington.

Vaughan, K., Gardiner, B. & Eyre, J. (2012). *A Transformational System for On-Job Assessment in the Building and Construction Industries*. Wellington: Ako Aotearoa.

Vaughan, K., Kear, A. & MacKenzie, H. (2014). Mate, you should know this! Re-negotiating practice after a critical incident in the assessment of on-job learning. *Vocations and Learning: Studies in Vocational and Professional Education, 7*(3), 331-344.

Ward, J. (1999). How large a Vocabulary do EAP Engineering Students need? *Reading in a Foreign Language, 12*(2), 309-323.

Ward, J. (2007). Collocation and technicality in EAP engineering. *Journal of English for Academic Purposes, 6*, 18-35.

Whatman, J., Schagen, S., Vaughan, K., Lander, J., Twist, J., Brooking, K., Robertson, S. & Spiller, L. (2010). *Engaging young people/young adults in literacy, language and numeracy skill development*. Wellington: Department of Labour.

Wilson, A.A. & Landon-Hays, M. (2016). A social semiotic analysis of instructional images across academic disciplines. *Visual Communication, 15*(1), 3-31.

Wood, A. (n.d.). *Action enquiry - Case study from the Department of Corrections*. Waikato: Wilf Malcolm Institute of Educational Research.

Woodward-Kron, R. (2008). More than just jargon: The nature and role of specialist language in learning disciplinary knowledge. *Journal of English for Academic Purposes, 7*(4), 234-249.

Workbase. (n.d., a). *Case Studies*. Accessed 22 January 2014 from http://www.workbase.org.nz/case-studies.aspx

Workbase. (n.d., b). *Literacy Profile: Carpenter*. Accessed 9 February 2014 from www.workbase.org.nz/media/15893/carpenterprof.pdf

Appendices

Appendix 1: Dissemination of findings: Conference presentations and how they relate to our objectives

Objectives	**Objective 6:** To disseminate our findings to support teaching of trades-specific language: Conference presentations:
Objective 1: To identify the vocabulary of trades-specific texts, whether spoken or written.	**Vocational/trades community in New Zealand** 1. Coxhead, A. (2016). Thermostat, propane and OSH: A technical and pedagogical word list of Plumbing. *New Zealand Vocational Education and Training Research Forum 2016*. Wellington, 18-19 October, 2016. **Language teaching community in New Zealand** 2. Coxhead, A. (2015). Joists, dwangs & pink batts: Writing and the specialised vocabulary of Carpentry. *Symposium on Second Language Writing*, 18-21 November 2015, AUT University, Auckland. 3. Coxhead, A. & McLaughlin, E. (2016). Exploring specialised language in the building trades: The lexical gap. *CLESOL Conference*, University of Waikato, Hamilton, 14-17 July, 2016 4. McLaughlin, E. (2016). Learning vocabulary in the carpentry context – insights from the classroom. *CLESOL Conference*, University of Waikato, Hamilton, 14-17 July, 2016 5. Coxhead, A. (2016). Corpus studies of vocabulary in the trades: Always take the weather with you. *ALANZ Regional Symposium*, Palmerston North, 19 November, 2016. 6. Coxhead, A. (2017). A pedagogical word list of Carpentry: Built through collaboration. *Asia Pacific Language for Specific Purposes and Professional Communication Conference,* 26-28 April Victoria University of Wellington. **International research community** 7. Coxhead, A. (2016). Specialised vocabulary in use: When research meets practice. *Language Use in Nordic Academic Settings (LUNAS)* 2016. 9-11 May, Copenhagen, Denmark. 8. Coxhead, A. (2016). Going with the flow: The specialised vocabulary of plumbing. *Vocab@Tokyo*, Tokyo, September 12-14, 2016. 9. Coxhead, A. (2017). Specialised vocabulary in context: Challenges for learners, teachers and research. *JALT Tokyo*, 14 February, 2017. 10. Coxhead, A. (2017). Specialised vocabulary. *TESOL 2017*, March 21-24, 2017, Seattle, USA. 11. Coxhead, A. (2017). Formulaic vocabulary in the trades: Applied Linguistics meets Automotive Engineering. *AAAL 2017*, March 19-22, 2017, Portland, Oregon.

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Objective 2: To identify discourse patterns of spoken and written texts.	**Language teaching community in New Zealand** 12. Parkinson, J. 2015. 'Writing for academic and occupational purposes: The case of the builders' diary genre'. Symposium on Second Language Writing, 18-21 November 2015, AUT University, Auckland. 13. Parkinson, J. (2017). Putting yourself into your work: Written and visual expression of the personal. *Asia Pacific Language for Specific Purposes and Professional Communication Conference,* 26-28 April 2017, Victoria University of Wellington. **International research community** 14. Mackay, J. (2014). Tracking the understanding of physics ideas in the trades: Trades tutors use of analogies in developing explanations of basic physics ideas. *International Commission on Physics Education Conference*. Cordoba, Argentina, August 2014. 15. Parkinson, J. (2017). Changing needs, changing contexts: Learning a workplace genre during training. *Faces of English Conference*, 1-3 June 2017, The University of Hong Kong, Hong Kong.
Objective 3: Investigate expression of visual meaning in trades texts.	**International community** 16. Mackay, J. (2015). The use of multiple representations in teaching "trades physics". *International Commission on Physics Education Conference*. Beijing, China, August 2015.
Objective 4: To identify the literacy and language demands of trades' language, with a specific focus on Pacific learners.	**Vocational/trades community in New Zealand** 17. McLaughlin, E., Mackay, J. and Cama, M. (2014). Language in the Trades. *New Zealand Vocational Education and Training Research Forum*. Wellington, New Zealand, 20-21 October 2014. 18. Parkinson, J. & Mackay, J. 2014. 'Language in the trades: The literacy demands of vocational study.' *Ako Aotearoa/Teaching and Learning Research Initiative: Research in Progress Colloquium IV*, 10-11 July, Wellington New Zealand. 19. McLaughlin, E. & Mackay, J. (2015). The Language in the Trades Project. Poster Presentation. Whitireia & WelTec Research Symposium, Wellington, New Zealand, 20th November 2015. 20. Parkinson, J. & Mackay, J. (2016). A model for developing resources: Improving literacy outcomes for Carpentry trainees. *NCVER Conference*. 4-6 July 2016. University Central Queensland, Australia.

Objective 4 continued:	21. McLaughlin, E. (2016). Embedding Literacy through Carpentry Diaries: Ideas, Frameworks and Practice. *National Centre for Literacy and Numeracy for Adults Symposium*. Te Papa, Wellington. 8-9 August 2016. 22. McLaughlin, E. (2017). Exploring the language and literacies of the trades: Learning through practice. *The 26th National Vocational Education and Training Research Conference,* 4-7 July 2017, Hobart, Tasmania. **Language teaching community in New Zealand** 23. Parkinson, J. (2014). 'Vocational Study: What are the literacy demands?' *14th National Conference for Community Languages and ESOL (CLESOL)*, 11th-13th July, Wellington, New Zealand. 24. McLaughlin, E. (2017). Working around the words: Unpacking language learning in vocational training. *Asia Pacific Language for Specific Purposes and Professional Communication Conference,* 26-28 April 2017, Victoria University of Wellington. 25. Coxhead, A., Tu'amoheloa, F. & Parkinson, J. (2017). Trades vocabulary in Pacific contexts: Tonga, Talanoa and corpus linguistics. *Asia Pacific Language for Specific Purposes and Professional Communication Conference,* 26-28 April 2017, Victoria University of Wellington. **International research community** 26. Parkinson, J. (2014). 'The literacy demands of vocational study in the engineering-related trades'. American Association of Applied Linguistics conference. March 22-25 2014, Portland, Oregon.

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Appendix 2: Classroom observation record sheet

Observation Record Sheet

Tutor:	Trade:	Course (Including level):
Date:	Date:	Observer:

1. **Curriculum Context** (Describe the circumstances and the role that class has in the broader curriculum)
2. **Physical context** (Describe the context of the class, the physical situation and the environment)
3. **Students** (describe the students; ages, gender, prior learning, issues, etc)
4. **Topic** (describe the topic under discussion in the class as well as the importance attached to this topic in the curriculum)
5. **Atmosphere** (describe the atmosphere in the class, comment on the power dynamics in the class – easy going, authoritarian, etc)
6. **Use of Language** (record instances of the use of technical and subtechnical terms in addition to complex discourse that you identify as being "trade talk" used by the tutor and also by the students. Where possible give examples. Also provide descriptions of instances of scaffolding and explicit teaching of language features of trade talk)
7. **Use of Diagrams** (describe the use of diagrams in teaching. What does the tutor get the students to do with the diagrams and why, how does the tutor use diagrams to develop specific language. Describe instances of talk about diagrams)
8. **Any other comments**

installation consortium supply reinforcing bearing
flow frame accordance angle compound fixing foundation
formwork bracing specifications construction voltage

Appendix 3: Initial interview with tutors

Tutor Interview: Name:	Trades:

1. What reading do students need to do in courses that you teach? Are they assessed on any of these and if so how are they assessed	
2. What writing do students need to do in courses that you teach? Are they assessed on any of these and if so how are they assessed?	
3. What speaking do students need to do in courses that you teach? Are they assessed on any of these and if so how are they assessed?	
4. What listening do students need to do in courses that you teach? Are they assessed on any of these and if so how are they assessed?	
5. Please mention any other language and literacy tasks that students in your courses do.	
6. Do your students have any language problems?	
7. If yes, what types of language problems do they have?	
8. Are there any particular problems to do with reading, writing, listening or speaking that your students struggle with?	
9. How do you deal with these problems?	

resistance drainlaying injection square compliance
alloy ground wear components face force
seal accordance method

10. What reading will students need to do once they are qualified and working?	
11. What writing will students need to do once they are qualified and working?	
12. What speaking will students need to do once they are qualified and working?	
13. What listening will students need to do once they are qualified and working?	
14. Please mention any other language and literacy tasks that students will need to do once they are qualified and working.	

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

Appendix 4: Interview with Carpentry tutors on stylistic features of diary

1. When I interviewed you and the other tutors before, you mentioned a number of different purposes for the diary. These were:

    1. Acquiring the habit of writing the diary
    2. Keeping a record for future reference:
    3. Job prospects
    4. The possibility of having to give evidence in court in the case of a dispute:
    5. A record of hours worked for billing
    6. Student assessment

    Which purpose(s) would you say is the most important (a) for you as a tutor and (b) for students. Why?

2. When we look at the students' diaries, we see 3 distinct ways of using language.

    A. The first is a personal style that uses:

    ① 'I', 'we', and their fellow classmate's names. For example when you look at the 2 examples provided you can see that the writers say 'Brandon and I continued to apply the plywood'; 'we managed to do it nicely'; etc.

    ② The personal style also is written in full sentences. The writers include a subject, full verb and object.

    ③ The writers use the past tense.

    B. The second style is an impersonal style:

    ① There is little or no personal language like 'I', 'we' or the names of their classmates.

    ② The diary is written in point form. In many cases the subject of the sentence is omitted.

    ③ Only part of the verb is included: 'Bank shaved back' (not bank was shaved back); 'Pipe and services all moved' (not pipe and services were all moved).

3. Which style do you prefer your students to produce? Why? Or doesn't it matter?
4. Which style is more like the diary of a professional builder?
5. Which style do you teach your students (if any)?
6. If we prepare resources/examples for your students, which style should be selected?
7. We are working on resources for students that might be of help with what to include in the diaries. To do that we have analysed some of the diaries to see the kind of things that the students include. We have done what is called a move analysis. Please look at the outline of moves that we found in the diaries.

    We found 6 moves.

    Move 1: Setting the context for building work
    Move 2: Detailing the materials and equipment
    Move 3: Detailing cost
    Move 4: Detailing building work
    Move 5: Evaluating building work
    Move 6: (Personal) comment unrelated to building

    To help us get this right, we'd like you to look at the moves and comment on them:

    a) Are the moves we have outlined sensible?
    b) Is anything missing?
    c) Is there anything you would leave out?

d) Are there any that you would like the students not to produce?

Appendix 5: Questions for tutors about teaching and learning vocabulary

- *Use these questions as a guide*
- *Use the list as a prompt for finding out how the tutors teach these words.*

Teaching

1. How do you decide which words to teach?
2. What strategies do you use – how do you teach them?
3. What do you teach them about that word:
   a. Spelling
   b. Meaning
   c. Pronunciation
   d. Use – put it in a phrase/sentence
   e. Word form (thing, action etc.)
   f. Collocations (words it normally goes with)
   g. Family words
4. What do you think are the most effective ways for teaching your learners new words?
5. What kind of words do learners know when they come to the programme – give examples
6. Where do you teach them the words – in the classroom, on the site or both?
7. Have you tried any strategies that weren't successful? What were they?
8. When do learners come across technical words?
   a. Tutor talk
   b. Student talk
   c. Assessments
   d. Workbooks
   e. Industry books/pamphlets, etc. (e.g. Gib book)
   f. ?
9. When do learners need to use these words?
   a. Talking to the tutor
   b. Talking to other learners
   c. Writing answers in assessments
   d. Writing answers in workbooks
   e. Writing in their builder's diary
   f. ?
10. What kind of words do learners have to use when they become apprentices and work in the industry?
11. What kind of difficulties do learners have with learning the technical vocabulary?
12. What kind of difficulties do learners have with using the technical vocabulary?
13. How do learners with low levels of literacy cope with understanding and using technical words? What do they do?
14. How do learners with low levels of literacy cope with understanding and using more general every day words e.g. barrier, division, section? What do they do?

15. What do you think is challenging about learning the technical words?
16. What do you think would help your learners to learn and use the technical words?

Appendix 6: Interview questions for Carpentry students to help build a picture of how they learn the vocabulary and what we can learn from that

Notes: Use these as a guide, but follow-up with any other relevant things they say about learning and using carpentry specific words.

Questions to guide the interview:

1. What carpentry words did you know before you started this course?
2. What is different between the words you used when you started and the words you use now?
3. What do you do when you hear a new word?
4. What do you do when you see a new word in an assessment or workbook?
5. How do you learn that word?
6. What does your tutor do to help you learn new words?
7. When do you use them and where do you use them?
8. How difficult is it to learn the new words:

1	2	3	4	5
Always easy	Often easy	Okay: sometimes easy, sometimes difficult	Often difficult	Always difficult

   a. Why? What are the biggest challenges?

9. Do you use glossaries?
   a. Why/why not? **b.** When?
10. What helps you learn and use carpentry words?

N.B. Find out if the learner speaks any other languages, background in English learning

Appendix 7: Bilingual English-Tongan wordlists: The first 25 words in each list

Automotive technology		Carpentry	
check	vakai'i	requirement(s)	ngaahi fiema'u
engine	mīsini	figure	fōtunga/fakakaukau'i
test	tesi: 'ahi'ahi'i	building	langa
voltage	volota	wall	holisi
figure	fōtunga/fakakaukau'i	timber	papa
pressure	fa'aki 'a ha fa'ahinga me'a 'i ha toe me'a 'e taha	roof	'ato
battery	puha 'uhila	concrete	piliki
vehicle	me'alele/saliote mīsini	installation	fokotu'u
fuel	lolo	construction	ngāue kotoa pē 'oku fai fekau'aki mo hono langa pe fokotu'u 'o ha fale pe vaka
circuit	sēkati: halanga takai 'o e 'uhila	fixing	fakatonutonu/fakalelei'i
air	'ea	calculation	fika'i/founga kumi pe fika'i 'o ha fa'ahinga me'a
complete	kakato	activity	ngāue ke fakahoko
operation/ operating	ko hono fakalele 'o ha ngāue pe mīsini	frame	alanga fale pe fa'unga 'o ha fa'ahinga me'a 'oku teuteu ke ngaahi
valve	vaolo	floor	faliki
reading(s)	lau pe koe fika 'o ha mita 'oku lau	site	feitu'u/tu'u'anga
work	ngāue	joint(s)	soini: ngaahi fo'i hoko pe mata hoko
control	pule'i/tuhani	development	fakalakalaka
resistance	fakafe'ātungia	material	matiliolo: naunau
connect(ed)	fehokotaki/hoko	carpentry	fakatufunga
current	kauleni/anga e vilo 'ae 'uhila	work	ngāue
correct	tonu	consortium	kautaha
coolant/ cooling	fakamokomoko pe fakamokomoko'i	point(s)	poini/faka'ilonga
flow	tafe	surface	fungame'a
require(ed)	fiema'u	cover(ed)	'ufi'ufi/fakapulou'i
sensor	senisā: me'a fakaongo	sheet	pepa
component(s)	kongokonga		

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

Fabrication		Plumbing	
welding	kasa	pipe	paipa
work	ngāue	drain	fakatafe
figure	fōtunga	building(s)	langa /ngaahi langa
cutting	kosi/tu'usi	require(d)/ requirement	fiema'u
tool(s)	me'a ngaue	gas	kasa
material	naunau/koloa	heat	tutu/mafana/tafu/ fakamafana
machine	mīsini	installation/ install(ed)	fokotu'u
source	ma'u'anga (ivi,'uhila etc.)	work	ngāue
steel	sitila	pressure	mālohi
centre	lotolotonga/ lotomālie	valve	vaolo
hazard	fakatamaki	air	'ea
metal	mētali/ukamea	supply	tokonaki/fakalato
equipment	naunau me'a ngāue	vent	fakamanava
check	vakai'i	discharge	tukuange
angle	'engikale	pump	pamu/komo
drill	vili	plumbing	ngāue fakapalama
surface	funga	tank	tangikē
measuring	fua	fixture	fakalelei'i
load	uta	level	lāvolo/mā'olunga tatau
line	laine	material(s)	naunau
point	poini	appliance	naunau
drawing	tā fakatātā	space	'atā/faingamālie
require(d)	fiema'u	flow	tafe
part	konga pe kongokonga	trap	tauhele
lifting	hiki/hiki'i pe fua	roof/roofing	'ato

diameter terminal sensor measuring regulations carpentry sensor clamping valve assessment trap carpentry level section

Appendix 8: Sample (first page) of tutor decision task: Are words technical words or not?

Please go through the following list of words and decide

1) (Column N) if each of the words is:

2 = an automotive word: brake, engine, spark etc.
or a word that is closely related to automotive: electrical, charge, wire etc.

1 = a word that is only minimally related to automotive: accurate, diameter, loose etc.

(if any?) 0 = a word that is very general and not related to automotive: basic, category, improve, etc.

2) (Column O) if you think you need to teach these words:

Yes = I need to teach this word

No = I never need to teach this word

Decision task for Automotive tutors		
Words	**Level of technicality: 2 / 1 / (0)**	**Do you need to teach this word? Y / N**
BATTERY		
VOLTAGE		
TEMPERATURE		
SWITCH		
BRAKE		
INSPECT		
ELECTROLYTE		
RUN		
FREE		
MAXIMUM		
COMBUSTION		
GASKET		
THROTTLE		
VARIATIONS		
SERVICEABILITY		
STEADY		
SPIN		
ANGLE		
CHUNKING		
RETHREAD		

Appendix 9: First 100 technical words in carpentry, plumbing, automotive technology and fabrication

Carpentry Sublist One:	Plumbing Sublist One:	Automotive Sublist One:	Fabrication Sublist One:
requirement(s)	pipe	pipe	welding
figure	drain	drain	work
building	building(s)	building(s)	figure
wall	require(d)/requirement	require(d)/requirement	cutting
timber	gas	gas	tool(s)
roof	heat	heat	material
concrete	installation/install(ed)	installation/install(ed)	machine
installation	work	work	source
construction	pressure	pressure	steel
fixing	valve	valve	centre
calculation	air	air	hazard
activity	supply	supply	metal
frame	vent	vent	equipment
floor	discharge	discharge	check
site	pump	pump	angle
joint(s)	plumbing	plumbing	drill
development	tank	tank	surface
material	fixture	fixture	measuring
carpentry	level	level	load
work	material(s)	material(s)	line
consortium	appliance	appliance	point
point(s)	space	space	drawing
surface	flow	flow	require(d)
cover(ed)	trap	trap	part
sheet	roof/roofing	roof/roofing	lifting
bracing	regulations/regulator	regulations/regulator	permit(ted)
safety	protect(ed)/protection	protect(ed)/protection	assessment
length	section	section	power
applied	design	design	area
finish	area	area	job
section	waste	waste	hard
steel	drainlaying/-er(s)	drainlaying/-er(s)	protective
cut	point	point	force
method	table	table	arc
area	service	service	hole
level	test	test	electrical

resistance drainlaying injection square compliance alloy ground wear components face force accordance method seal

Carpentry Sublist One:	Plumbing Sublist One:	Automotive Sublist One:	Fabrication Sublist One:
specifications	metre(s)	measure	wear
complete	standard	fault	form
structural	control	carry	engineering
line	temperature	repair	table
load	form	ignition	grinding
cladding	hot	drive	sling
ceiling	metal	charging	finish
set	surface	steering	alloy(s)
support	figure	unit	face
edge	gasfitting	speed	edge
door	store(d)/storage	injector/injection	gas
joist(s)	measurement	adjust	shape(s)
space	locate(d)/location(s)	wheel	heat
formwork	device	heat	fire
plate	prevent	coil	circle
nail(s)	maintenance	damage	square
plan	equipment	position	position
information	electrical	manufacturer(s)	wire
check	hazard(s)	weld	joint
centre	stack	perform(ed)/-ance	strength
table	ground	service	carbon
stud	burner	lead	wheel
location	confine(d)	clutch	component(s)
protection	outlet	bearing	marking-out
compound	site	electrical	accurate
design	code	terminal	mark
reinforcing	rate/rating	pass	resistance
tool(s)	sanitary	supply	calculate
coat	check	specifications	bolt
board	access	plug	feed
size	seal	step(s)	method
manufacturer	comply/compliance	wear	fit
standard	additional	leak(s)/leakage	clear
foundation	steel	tool(s)	maintenance
beam	means	point	punch
bear	joint(s)	procedure	standard
hazard	concrete	power	nut
truss	method	replace	clamping
block	license	plate	storage / stored

clutch standard procedure square ignition carbon
coolant gasfitting weld hazard cylinder clutch harm
currnet marking-out

Carpentry Sublist One:	Plumbing Sublist One:	Automotive Sublist One:	Fabrication Sublist One:
plasterboard	cylinder	electronic	diameter
house	accordance	filter	harm
insulation	tool(s)	light	fabrication
range	trench	number	adjustable
sealant	grade	shaft	corrosion
batten(s)	exemption	contact	workplace
lining	draft	fail	metre(s)
product	block(s)/blockage	motor	cast
member(s)	atmosphere/-ic	area	level
contractor	liquid	gauge	current
metal	rectangle	spring	procedure(s)
prevent	reduce(d)	level	aluminium
resistance	relief	transmission	electrode
rafter	soil	locate(d)/location	location
scaffolding	construction	tyre	chuck
adhesive	flue	spark	activity
pile(s)	tonic	compression	temperature
formula	structure	material	piece
maximum	chamber	body	hammer
horizontal	resistance/resistant	relay	iron
height	replacement	run(ning)	supervisor
flashing	force	meter	vice
element	inspection/inspect(ed)	gear	lathe
consent	manufacturer(s)	job	sheet
exterior	subscribe(d)	idle	bend

Appendix 10: A diary entry written by an apprentice trainee

104 XXX Road

27 March to 5 March

Formwork for concrete. 12mm strips of ply ripped down to 450mm in height. Used wooden pegs to hold ply to curve of existing concrete 200mm spaces, between existing wall and ply boxing. Use wood 4x2 braces to hold ply boxing. Peg end of braces. Set up another strip of ply curve. Screwed to timber & to create to nib that the concrete level will come up to. Set to 170mm to give spacing. De-box nib concrete wall and took off all braces and pegs out. Edges curve. Steel float.

Appendix 11: Move analysis of a diary entry written by a level-three trainee

Day 42	Move 1 Strategy 1: Detailing date/time of day
Finished off putting up all the trusses	Move 1 Strategy 5: Identifying work as a stage in a sequence
We got given Z nails	Move 2 Strategy 1: Detailing materials/fixings
which help support each truss.	Move 4 Strategy 3: Detailing purpose/reason
We put these on the non-offset trusses,	Move 4 Strategy 1: Detailing task
and used special metal straps	Move 2 Strategy 1: Detailing materials/ fixings
to help support the offset trusses.	Move 4 Strategy 3: Detailing purpose/reason
We finished off the day inside	Move 1 Strategy 3: Detailing where the work was done
working on Trigonometry	Move 4 Strategy 1: Detailing task

Appendix 12: Ethics Approval

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Phone 0-4-463 5676
Fax 0-4-463 5209
Email Allison.kirkman@vuw.ac.nz

MEMORANDUM

TO	Jean Parkinson
COPY TO	Averil Coxhead
FROM	Dr Allison Kirkman, Convener, Human Ethics Committee
DATE	13 August 2013
PAGES	1
SUBJECT	**Ethics Approval: 19989** **The Language in the Trades Project**

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 31 January 2016. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman
Human Ethics Committee

Appendix 13: Diary Evaluation Rubric

Location			Type of work		
CRITERIA	**1. Does not fulfil the criterion**	**2. Partially fulfils the criterion**	**3. Fulfils the criterion**	**4. Fulfils the criterion and goes beyond what is expected**	**Cannot Judge. Too little information**
Materials, Product Information, Tools and Fixings	**No** information given on materials, products, tools and fixings used	**Some** information given on materials, products, tools and fixings used	Mentions (lists) materials used, product information, appropriate tools used and appropriate fixings.	More detail than expected and supporting photo	
How the job was done. Issues and Problems	**No** description of how the job was done	**Some** key processes have been left out of the description	Describes how the job was done including most key elements. Describes how the fixings were used	Describes how the job was done and how the fixings were used. Discussion on issues and problems that have arisen	
Drawings, Photographs and Text	**No** photos or diagrams	**Some** photos and diagrams used, but no supporting text	Shows work done through either photos or drawings (or both) and uses text to explain the photos	High quality drawings that are detailed and labelled. High quality photos with detailed supporting text	
Language level and use of terminology	**No** understanding of terms used	**Some** understanding of terms used	Shows appropriate understanding of all terms used. They are used properly	Shows a detailed knowledge of terms used, that is more than required	
General Comment					

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