Dialogic Activity: A Study of Learning Dialogues and Entanglements in a Vocational Tertiary Setting

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Abstract

New Zealand's economic growth continues to place major pressure on the trades sector. To meet future demand for qualified builders, plumbers, electricians, and engineers, trades education has become available at no cost to students for two years. To attract student interest further, tertiary institutions now offer courses in a range of delivery options. Blended learning (BL) is one of these delivery modes and involves a combination of traditional face-to-face and digitally mediated approaches. This research explored students' dialogic activity in a BL environment, within a trades educational institution. The dialogues that emerged during trades training courses were examined in relation to a complex assemblage of elements, which included interactions between students and teachers, and the digital and materials artefacts in the BL environments.

The research used an interdisciplinary lens, employing theories of socio-materialism and dialogism, to unpack forms of dialogic activity that emerged within the BL environment. That same lens was used to reveal the part that material and digital artefacts played in the emergent dialogic activity. Conducted as a multiple case study, the research involved observations of instructors and student participants from three Level 3 pre-apprentice trade programmes, which provided a wide range of data over the course of one semester. Datasets from Automotive Engineering, Electrical Engineering and Mechanical Engineering, as the three cases involved, were analysed to explore the contextual meaning of the learning dialogues and activities in action.

The findings revealed that learning dialogues occur in multiple contexts and environments. Artefacts and their properties, BL designs, open and flexible learning spaces, environmental conditions, health and safety considerations, embodiment, multiplicity, mediation, and class culture, all have a significant influence on dialogic activity. The findings offer important insights about the link between course design and learning and identify dialogic activity as an interdisciplinary phenomenon that warrants further investigation.

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For Peter, Katelyn, John, Poppy, Mom, Dad (posthumously), and Susan

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1 Introduction

In New Zealand, qualified trades apprentices are in high demand due to population and economic growth. New Zealand Immigration (2020) currently identifies a shortage of tradespeople, including builders, plumbers, electricians, engineers and, until 2020, individuals with those skillsets were given prioritised entry into the country to fulfil work demand. The government has acknowledged the shortage by prioritising trades education with the provision of two years' free tuition for trades-related degrees (Ministry of Education, 2020c). To meet the expectation of increased student enrolment, tertiary trades institutions offer courses in a range of delivery options, including blended learning (BL). BL involves any combination of traditional and e-learning approaches, may include different media and is usually delivered in modules of learning (B. Alexander et al., 2019; Brown et al., 2020; Milanese, Grimmer-Somers, Souvlis, Innes-Walker, & Chipchase, 2014).

The most recent student enrolment data published by *Education Counts*, New Zealand Ministry of Education's statistics website, showed that, in 2020, 21,800 students enrolled in Level 3 certificate vocational education courses from a total of 380,255 students enrolled in tertiary education courses (Ministry of Education, 2020d, 2020e). Vocational education enrolment rates for Level 3 certificates in Automotive, Electrical, and Mechanical Engineering in New Zealand have remained relatively stable from 2010 to 2020 averaging 7,391, 9,881, and 7,931 respectively per annum (Ministry of Education, 2020e). However, despite efforts to make vocational education meaningful to, and valued by, students, the attrition rates for students, as *Education Counts* clarifies, remain relatively high, revealing that, the trades student attrition rates for Automotive Engineering, Electrical Engineering and Mechanical Engineering Level 3 certificate courses averaged 40%, 36%, and 33% respectively from 2006 to 2019 (Ministry of Education, 2020b). By investigating the learning experiences through student dialogue, this research seeks to understand what is meaningful to, and valued by, students in three trades educational settings—Level 3 certificate courses for Automotive, Electrical and

Mechanical Engineering. From that understanding, the research may offer suggestions about what might improve completion rates in trades education.

1.1 The Problem

Although research on BL environments seems to support the idea of its potential within vocational tertiary education, questions remain about how well BL truly works in these settings, and whether it does deliver on its promise (Bliuc, Casey, Bachfischer, Goodyear, & Ellis, 2012; Milanese et al., 2014; Nore, 2015). Positives seem to be that it is somewhat more effective than online learning or solely face-to-face learning: it is cost efficient from the employer's point of view in time off work for trades pre-apprentices and it gives them flexibility in regard to learning opportunities (Bouilheres, McDonald, Nkhoma, & Jandug-Montera, 2020; Nore, 2015).

In addition, multiple pedagogical approaches may be used in any given learning environment. With each pedagogical approach, there will be sets of conditions to support, model and engender learning dialogues in educational settings. However, in the trades education context of this research, and depending on the individual trade, students are introduced to a range of specific vocabularies and skillsets, involving the use of specific tools, ways of being, and ways of speaking (Chan, 2021). Trades students are required to master them in order to participate fully in their prospective trades as apprentices and eventually as licensed practitioners (Chan, 2021; Lave & Wenger, 1991).

As will be discussed in the literature review, significant research has been conducted on learning dialogues, dialogic education, BL course designs, and the material aspects of learning. Each of these is a significant individual research interest. However, the literature has failed to address the interdependencies of these research interests (R. Alexander, 2020; Bakhtin, 2010a, 2010b; Bliuc et al., 2012; Callan, Johnston, & Poulsen, 2015; Chan, 2020a; Chan, Baglow, & Lovegrove, 2019; Hennessy, 2011; Hetherington, Hardman, Noakes, & Wegerif, 2018; Mercer, 2002; Milanese et al., 2014; Phillipson & Wegerif, 2017). This present research focuses on addressing this gap. It employs a socio-materialist lens to explore the ways in which learning dialogues, dialogic education, BL course design, and the material aspects of learning are intertwined. To assist in that investigation, I propose the term *dialogic activity*, as a phenomenon that is inclusive of specific types of learning dialogues defined as shared knowledge, shared inquiry and reflection that emerge within a dialogic space and in simultaneity with activity in a learning context (Wegerif, 2013).

1.2 Purpose

This study pays special attention to the capacity of learning dialogues to impact student experiences. That is, the interdependencies of blended course designs and student and teachers' emergent activity provide a focal point for this study. To participate fully as apprentices and eventually as licensed practitioners, students must learn the ways of becoming an apprentice (Chan, 2021) including ways of using trades-specific languages. Students employ learning dialogues alongside their activity to gain an understanding and basic mastery of the tools, materials, and concepts required to participate in their respective trades communities. The present research is grounded in the understanding that a symbiotic relationship between learning dialogues and learning activity exists: learning dialogues mediate learning activity and learning activity mediates learning dialogues. It attempts to gain an understanding of the complexities between people and materials in BL environments and the emergent dialogues within the trades training. It is within this context, at the intersection of students' embodied acts of using digital and material tools, whilst they engage in learning dialogues, that I situate this research and propose the term and phenomenon, *dialogic activity*.

Further, this research considers dialogic activity in the context of learning entanglements (Hodder, 2012). That is, learning entanglements that arise due to the socio-material assemblages of students and the artefacts or things they use (both digital and physical). This research, then, seeks to investigate dialogic activity as an emergent phenomenon within learning entanglements on tertiary trades students. It specifically asks:

1. What dialogic activity emerges in a learning entanglement?
2. How do material and digital artefacts in a learning entanglement impact dialogic activity?
3. What are students' perspectives about dialogic activity in a learning entanglement?

These research questions were designed to determine the kinds of dialogic activity that emerge within learning entanglements in BL course designs, to determine the ways in which digital and physical artefacts influence learning and dialogic activity, and to identify students' perspectives about dialogic activity within learning entanglements.

1.3 Methodology

This participant ethnographic study employs a multiple-embedded case design using data collected over the course of one semester at New Zealand's largest tertiary trades institution, Unitec Institute of Technology. The participants included a total of five instructors and a total of 14 students from three Level 3 pre-apprentice trade programmes including Automotive Engineering, Electrical Engineering and Mechanical Engineering. Data collected included video transcription, field notes, artefact collection, student weekly self-reflection questionnaires and student and instructor participant interviews. Passages of interest were identified from the field notes as critical episodes. Critical episodes were cross-referenced with student self-reflection questionnaires and placed into customised multimodal mapping tables in Excel and analysed alongside other collected data as narrative "vignettes" (Hennessy, 2020). That is, they were crafted into stories about the critical episode or learning situation, including instructor responses about course design with student reflection questionnaire insights, and student perspectives based on their interview data and observations. These tables logged the associated dialogic activity including the identified the critical episode, the BL mix, the digital, physical or combination of elements in the learning environment, the social configuration of participants involved, the artefacts used, if the critical episode was chosen as a vignette, the evidence of dialogic activity, and the themes that arose from them (Hennessy, 2020; Kershner, Hennessy, Wegerif, & Ahmed, 2020). Additionally, the findings from the chosen vignettes for each case in these tables were compared to the semi-structured interviews—both as a measure for the triangulation of the data and to identify emergent research themes.

1.4 Definition of Terms Used in the Thesis

This thesis includes multiple terms that represent the key concepts and definitions used for this research. Hodder's (2012) Entanglement theory, described in detail in the Theoretical Review chapter, highlights the dependencies between humans and things through the lens of solving a problem. As a "conjunctural event" occurs, it leads to a "problem" to which a "solution" is then devised (Hodder, 2012). The conjunctural event disrupts the activity, resulting in a problem which requires a solution (Hodder, 2012). During each observed session, I noted in my field notes either a "conjunctural event" or a *critical episode* of interest. A *critical episode* represents a learning situation of interest or significance to the study participants in this research context.

The word *dialogic* in *dialogic activity* describes the utterances of shared knowledge, shared inquiry, and reflection (both uttered and not) while the word *activity*, in *dialogic activity* acknowledges student agency and situated experiences with materials or artefacts both digital and physical within the context of the dialogic space, the ecosystem of the learning environments. The words combined as *dialogic activity* acknowledge the doing alongside the shared utterances and reflective acts experienced in multiplicity within the dialogic space bound within the digital and physical learning environment (Dawes, Mercer, & Wegerif, 2004; Wegerif, 2006). In addition, I use the terms *learning dialogues* and *learning talk* interchangeably for this research. They refer to the types of shared knowledge, shared inquiry and reflection that occur within dialogic activity. This research context foregrounds the role and consideration of the face-to-face and digital learning environments, called *blended learning* (BL). For this research, BL involves any combination of traditional and e-learning approaches and may include different media (B. Alexander et al., 2019; Brown et al., 2020; Chan, 2020b, 2021; Milanese et al., 2014). Material artefacts, or things, are defined as any physical materials utilised in the BL environments—such as pens, welding equipment, paper, and hammers. Alternatively, digital artefacts are defined as any digital tools or materials utilised in the BL environments, such as Google search results and digital course content or activities conveyed through a learning management system (LMS).

While, the dialogic activity is observed through the lens of learning entanglements, the organisational components of the BL course designs in this research are arranged through the Activity-Centered Analysis and Design (ACAD) framework (Carvalho & Goodyear, 2014; Goodyear, Carvalho, & Yeoman, 2021). ACAD is organised into four, mutually exclusive components: *"set design"* refers to physical or digital structures such as lecture rooms or a learning management system*, "epistemic design"* includes tasks and assessments, and *"social design"* involves student social organisation, such as groupings. The fourth ACAD dimension is the "*co-creation and co-configuration activity*," and refers to the emergent activity of students at the time they interact with the assemblage of elements designed in advance by their lecturers. These four domains are described in detail in the Theoretical Review chapter (Carvalho, Goodyear, & de Laat, 2016; Goodyear et al., 2021).

In addition, within the ACAD framework, *flexible learning environments (FLEs)* are part of the physical learning environments (*set design*) in which students are able to physically move or reconfigure their desks or equipment (Goodyear et al., 2021) which can impact activity and the communicative experiences of students (Carvalho & Goodyear, 2014; Carvalho et al., 2016; Ravelli & McMurtrie, 2016).

1.5 Positioning Myself as a Researcher

The key interest in the emergence of learning dialogues and activity within BL course designs stems from my own experience as an academic advisor and learning designer in tertiary education. In my capacity as a learning designer, I work alongside academic staff in the design, development or re-development of their courses ranging from the identification of learning outcomes, assessment design, task design, and constructive alignment to advice on the presentation of their courses in digital, physical, or BL formats. BL course designs piqued my interest most especially in these material-rich learning environments for trades education. I chose to investigate these environments more deeply through the lens of dialogism while acknowledging the importance of the materials in students' learning activity. Influential in this decision were the works of Mikhail Bakhtin (2010a, 2010b), the originator of dialogism, and Ian Hodder (2012), the originator of entanglement theory. Thus, I began my journey into the exploration of the words we say and the activities we do when learning is a shared experience. I wanted to investigate how activity and learning dialogues are experienced and how the material and digital elements, activity, and dialogues may hinder or facilitate learning within courses. This study signifies the beginning of my exploration of the phenomenon, dialogic activity.

1.6 Organisation of This Thesis

Chapter 1 introduces the research problem, purpose of this research, definitions of key terms, my position as a researcher, a brief overview of the methodology, and an outline of this thesis.

Chapter 2 presents a review of the literature situating this study and providing a justification within the context of scholarly research. It begins with a brief historical background of dialogic education and provides a discussion about its relevant domains, such as initiation, feedback and response exchanges, initiation feedback and evaluation exchanges, analogies, dialogic teaching, thinking together, and dialogic space. It continues with an explanation of BL environments in trades education contexts, students' perceptions of them, communities of practice, learning networks, student agency, and flexible learning environments, by making a case for the many different elements that influence dialogic activity.

Chapter 3 presents a theoretical review and situates this thesis within the body of socio-materialist education. It describes entanglement theory and dialogism as the interdisciplinary theoretical basis for this thesis. Included are a description of the ACAD framework and a discussion of its importance to course designs. It explores connections between materials, embodiment, language and thought to dialogic activity and its interdisciplinary theoretical foundations.

Chapter 4 presents the methodology for this research. This participant ethnography study uses a multiple-embedded case design with data collected over the course of one semester from five instructors and 14 student participants, each from three Level 3 pre-apprentice trade programmes at Unitec including Automotive Engineering, Electrical Engineering and Mechanical Engineering. Data collected included video transcription, field notes, artefact collection, student weekly self-reflection questionnaires and student and instructor–participant interviews. Passages of interest were identified from the field notes as critical episodes. These critical episodes were written up as vignettes, or stories about the critical episodes, by use of video transcripts and by using discourse analysis to explore the contextual meaning of the learning dialogues and activities in action .

Chapter 5 presents the first case, "Dialogic activity in an Automotive Engineering tertiary learning environment." It begins with the designed elements of the BL course and continues with three vignettes that describe the quality of materials in learning, reflections about artefacts, and the role of an open learning space. The chapter concludes with a discussion of the students' perspectives and the case findings.

Chapter 6 presents the second case, "Dialogic activity in an Electrical Engineering tertiary learning environment." The chapter commences with a description of the designed elements of the BL course, followed by a description of three vignettes including an analogy as a dialogic tool, schematics and photos as mediational tools, and mathematics as a mediational tool. The chapter concludes with a discussion about the Electrical Engineering students' perspectives and case findings.

Chapter 7 presents the third case, "Dialogic activity in a Mechanical Engineering tertiary learning environment." The chapter begins with the designed elements of the BL course design. It continues with a discussion of three vignettes including planning as a dialogic activity, the role of support technology, and problem solving as dialogic activity. The chapter concludes with a discussion about the overall Mechanical Engineering students' perspectives and case findings.

Chapter 8 coalesces the findings from the three cases and is titled, "A discussion of dialogic activity within the three learning environments." This chapter reports the emergent themes including the types, significance, and affordances of learning dialogues. It includes the components of dialogic activity (shared knowledge, shared inquiry, and reflection), dialogic spaces, cumulative dialogues, schematics, mathematics, and dialogues as themes within trades communities of practice and networks. The role of materials and artefacts within BL environments as well as physical, flexible learning environments are also addressed. Additional themes of embodiment, multiplicity, and mediation as well as health and safety are explained. Finally, students' perspectives are considered and the importance of class culture in enabling dialogic activity is shown.

Chapter 9 presents the concluding insights gained from this research. It summarises the major themes based on each of the research questions, discusses findings that were peripheral to the research, and explores recommendations for future research. The key messages about dialogic activity and its role in BL environments, including the theme that learning dialogues occur in multiple contexts and environments, are discussed in detail.

In the next chapter, I present a review of the literature for this research.

2 Literature Review

2.1 Introduction

In this chapter, I provide a review of the literature relevant for this research. A brief history of dialogic education is reviewed along with the acknowledgement of key research conducted in the field. An overview of BL environments is presented, as well as students' perceptions of them. I introduce the notions of communities of practice, learning networks, and innovative learning environments as they relate to this study. These topics provide the foundational basis to justify the term dialogic activity.

2.1.1 History of dialogic education

Dialogues and their role in education have deep historical roots. Scholars recognise that dialogic education first began with Socratic questioning techniques (Plato, 1962, 2005; Wegerif, 2013). Central to this questioning technique are provocative philosophical questions, such as "What is the meaning of life?" This technique highlighted contradictions in students' thinking by challenging their beliefs through questioning techniques posed by the instructor (Matusov, 2009; Wegerif, 2013). Centuries later, Buber (1970) theorised dialogues as dynamic, and instead of challenging students' beliefs, characterised the nature of dialogues as the thinking between the self in relation to others. He identified two viewpoints central to his philosophy: objectification "Ich – Es"("I -It") and dialogue "Ich – Du" ("I – Thou") (Buber, 1970, p. 53). That is, internal dialogues exist between what is perceived by the mind and the act of perceiving things (Wegerif, 2013). Buber described this phenomenon as "das Zwischen" or "in-between," as the shared space between participants within the dialogues (Buber, 1970; Kershner et al., 2020). This notion of in-between is one of the key ideas that provides a foundational basis for dialogic education.

Another body of work influential to dialogic education is the work of the theorist Habermas. Habermas (1971) believed that people, fundamentally, try to understand each other through discourse, and that discourse creates the foundational conditions for seeking understanding. These foundational conditions are similar to Buber's *in-between* in that intersubjective conditions must first exist when one is seeking these understandings (Habermas, 1971). For Habermas, understanding (secondary to foundational understanding) and winning arguments or solving problems is part of any critical discourse. Habermas (1971) suggested that critical learning is a reflective process that underlies the shared understanding or knowledge upon which critical thinking can be generated. Critical learning represents an important concept underlying dialogic education. By way of example, Freire proposed dialogues as a medium for the oppressed to speak their own minds in the world, rather than as products of an oppressive system (1970). Freire's (1970) work focussed on social justice and, for him, dialogues were seen as enabling social change, freedom of expression or free and open dialogues for mankind.

Oakeshott (1959), on the other hand, viewed dialogues as existing with greater humanity and mankind, beyond social justice. He believed that the purpose of education is to, not only increase students' understanding, but to enable students to be participants in the conversation of mankind (Oakeshott, 1959). To Oakeshott, dialogues represent a means within themselves not a means to an end, such as for personal benefit. Oakeshott argued there was no privileged, outside view; rather he believed that multiple voices, and their interplay of ideas, played an essential role in the formation of a perspective. That is, facts are never fixed but, rather, rise and fall out of greater societal dialogues (Oakeshott, 1959).

The key concepts offered by Oakeshott influenced the theories of Mikhail Mikhailovich Bakhtin, the "father" of dialogism, a Russian literary thinker and philosopher (Holquist, 1981). Bakhtin formulated his collected works based on Socratic questioning techniques, Freire's notion of dialogues for social change (not oppression), Oakeshott's greater conversation of mankind, Buber's concept of "in-between," and Habermas' concept of foundational knowledge and critical thinking. Bakhtin (2010b) proposed written and verbal forms of shared understandings and inquiry and reflection as key partners within the spaces in which dialogues occur (Buber, 1970; Freire, 1970; Habermas, 1971; Holquist, 1981; Kershner et al., 2020; Oakeshott, 1959; Wegerif, 2013). For Bakhtin (2010b), dialogues are never ending: “if an answer does not give rise to a new question it falls out of the dialogue…” (p. 168).

It is dialogism that underpins dialogic education (Kim & Wilkinson, 2019). Dialogic education provides students the space for the exploration of their own and others’ ideas through questioning and answering. The aim of the dialogic approach in a Bakhtinian sense is to provide sustained opportunities for the interchange of ideas in order for mutual knowledge to develop and lead to further inquiry or questions (Bakhtin, 2010b). It is the Bakhtinian approach to the dialogic that has impacted, at large, on the modern movement of dialogism in education today.

2.2 Dialogic Education

Dialogic education encompasses many approaches and contexts (Kim & Wilkinson, 2019). A large body of research on dialogic teaching and learning has been conducted in primary and secondary schools (Alexander, 2001, 2020; Lefstein & Snell, 2013, Mercer, 2002; Mercer, Wegerif, & Major (Eds.), 2019; Wegerif, Linares, Rojas-Drummond, Mercer, & Velez, 2005; Sedova et al., 2019, Wegerif, Littleton, Dawes, Mercer, & Rowe, 2004). In addition, a large body of research on dialogic teaching and learning has centred on science curricula for middle schools and secondary schools (Davies & Esling, 2020; Davies & Kiemer, 2018; Davies & Sinclair, 2014; Hetherington et al., 2018; Hofstein & Lunetta, 2004). Whilst research on dialogic education in the tertiary environment is growing, research on dialogic education in the tertiary trades environments, known as material-rich and science-based educational domains, remains in its infancy. Because of the minimal body of literature focussed on dialogic education in tertiary trades environments, I have drawn upon the several key dialogic education approaches and studies to situate this research.

2.2.1 Initiation feedback response and initiation feedback evaluation

In classrooms, the importance of talk and teacher student exchanges were initially examined by the linguists Sinclair and Coulthard (1975) in United Kingdom classrooms. What they found is that classroom talk was mostly comprised of an Initiation Response Feedback (IRF) loop. IRF expresses types of talk in which a teacher would ask a question, students would provide feedback and then the instructor would respond to them. On the other hand Mehan (1979), a sociologist, focussed his attention on the power relations and social order of the classroom, adding a new dimension to talk as instrumental. He identified Initiation, Feedback, and Evaluation (IFE) as common in the classroom. Other researchers found this type of talk or sequencing to be somewhat manufactured and considered that these did not provide room for students' agency (Lemke, 1990). For example, Barnes (2008) argued that these exchanges provided no opportunities for students to comment or voice their own ideas and, to their detriment, engendered student passivity. However, it is generally acknowledged that IRF–IRE exchanges do provide a language for understanding how learning talk may emerge (R. Alexander, 2020; Mercer, 2002). These structured exchanges are useful when students are beginning to learn a topic or skill and may eventuate into other types of talk (R. Alexander, 2020; Dawes et al., 2004; Mercer, 2002).

2.2.2 Analogies

One of the ways pre-apprentices engage with the language of their trade is by using analogies (Parkinson et al., 2017). Filliettaz, de Saint-Georges, and Duc (2010) propose that "analogical discourse" is often used in vocational training. The researchers analysed audio-videos taken in Vocational Education and Training (VET) classrooms involving three technical trades, car-mechanics, automation and electric assembly (Filliettaz et al., 2010). The participants included apprentices and experts in vocational schools and training companies. Using over 140 hours of recordings and 42 sequences of transcribed analogical discourse, the researchers identified the sequences in which knowledge was associated with "another domain". For example, they found evidence of descriptions of electricity as water and molten metal as liquid Swiss fondue. Phrases such as "it looks like," "a little bit the same as," "for example" and "it's like" were used as reference points for the analysis. The researchers found that analogies were used extensively and were significant in contextualising students' learning with understanding and constructs they already knew (Filliettaz et al., 2010). Furthermore, students could individually or collectively generate analogies and that the use of analogies impacted the social, cultural, and relational aspects of their learning environment. This research showed that analogies can act as a bridge between thinking and learning by referencing known experiences to those unknown. Whilst the study suggested that analogies offer a significant pedagogical strategy to promote dialogic activities in a trades environment, the way in which the shared understandings and inquiries of the students were impacted was not recorded.

2.2.3 Dialogic teaching

Dialogic teaching is premised on the understanding that language is foundational for learning. Dialogic teaching is not just any talk conducted by an instructor in a course setting. It distinguishes itself from the traditional question-and-answer classroom dialogues and casual or informal conversations by describing a type of talk that enables students to understand, learn and think together. Dialogic teaching places the instructor in an instrumental role of enabling and modelling classroom dialogues. It is particularly common to teach this way of thinking through utterance (Kim & Wilkinson, 2019).

Scholars have offered a range of definitions for dialogic teaching. Kim and Wilkinson (2019) performed an extensive review of the literature, describing different dialogic teaching approaches and definitions of dialogic teaching in their seminal article "What is dialogic teaching? Constructing, deconstructing, and reconstructing a pedagogy of classroom talk." From their critical review of the literature, Kim and Wilkinson identified three domains of dialogic teaching which included issues or highlights, namely: (i) discourse form and function; (ii) the role of classroom culture; and (iii) general pedagogical approach or specific discourse practice. The domain of discourse and function acknowledges the using of linguistic techniques such as *open* over *closed* questions and usurped the importance of context within which dialogues occur. This domain focusses on the linguistic aspects of questions introduced by the teacher decontextualised from the learning dialogues (Boyd & Markarian, 2011; Kim & Wilkinson, 2019; Soter et al., 2008). The second domain is also key to enable the success of learning dialogues. The authors agreed with Alexander's (2020) principles that classroom dialogues should be "collective, reciprocal and supportive". The third domain refers to teaching approaches, particularly those that tend to privilege dialogues and discussions which involved the strategic use of different types of talk on a continuum, from repetition to dialogue. Their investigation found that classroom culture gives power to the talk just as much as talk gives power to the classroom culture and that dialogic teaching provides important support for productive dialogues to extend students' problem-solving, thinking and learning (Kim & Wilkinson, 2019). Significantly, Kim and Wilkinson coalesced the varied definitions in the current research about dialogic teaching and provided a definition of dialogic teaching which is applicable to multiple research approaches.

2.2.4 Talk for learning

Robin Alexander's seminal work on dialogic teaching is drawn from his comparative analysis research on primary education in England, France, India, Russia and the United States conducted between 1994 and 1998 (R. Alexander, 2001). Employing interviews, observations, video, and audio recordings, Alexander and his research team found similarities in talk across the different cultures with some subtle differences between schools in the same county as well as between different countries. One of the main findings that arose from this study is that different types of talk are useful for extending students' learning. Their findings have informed a key principle of dialogic teaching (R. Alexander, 2001; Kim & Wilkinson, 2019).

Alexander's dialogic teaching has been particularly influential in the United Kingdom, especially for primary and secondary teaching (R. Alexander, 2001, 2020; Kim & Wilkinson, 2019). Alexander defined dialogic teaching as a general pedagogy which "extends students' thinking, learning and knowing" (2020, p. 128). The revised version of his teaching framework includes sections about its purpose, distinctive features, differences between his current version and earlier versions, definitions, stance, justifications, principles, repertoires and indicators (R. Alexander, 2020, p. 126). Key to this pedagogy is the notion of *repertoire*. That is, teachers approach any teaching with a set or repertoire of skills and tools they use to organise and interact with, including talk, and use different organisational strategies with the whole class, student or teacher led groups, small group work and one-to-one work. The types of classroom teaching talk involve rote, recitation, and discussion. It also includes learning talk or practices for students such as argumentation, explanation, description, and narration. Teaching talk may sometimes be structured as rote or IRF/IRE sequences or exposition, and other transmission types of talking, dialogues and discussions are often privileged within dialogic teaching. Importantly, for Alexander, dialogic teaching involves purposeful guided questioning and prompting to achieve shared knowledge, understandings, and solutions. This guided questioning technique is influenced by the instructor's *dialogic stance*. That is, the instructor's sustained focus on the students through questioning can be influenced by the instructor's background knowledge and experience (R. Alexander, 2020).

Alexander (2020) bases his dialogic teaching framework on six principles: "collective, supporting, reciprocal, deliberative, cumulative, and purposeful" (p. 131). The *collective* principle describes the learning experiences in the classroom as a group activity and where a general willingness to learn together is shared amongst the students and teacher. Conditions in class in which students speak freely without fear of judgement from others for their views is known as the *supportive* principle. The *reciprocal* principle allows students and teachers to freely share their ideas, ask questions and consider alternate viewpoints. In addition, conditions in which participants in the dialogue actively discuss and seek to resolve differing viewpoints and in which they learn to evaluate arguments and work together toward shared outcomes is known as the *deliberative* principle. Finally, the *cumulative* principle means that participants in a dialogue build upon their own and each other's reasoning and chain them together to build understanding and thinking. The cumulative principle most closely mirrors Bakhtin's thinking in that a question gives rise to another question (Bakhtin, 2010b; Kim & Wilkinson, 2019). Finally, the *purposeful* principle means that questioning techniques are designed with specific learning goals, even if the dialogue is open-ended.

In the trades environments, instructors guide and teach with specific language genres (Bakhtin, 2010b); that is, dialogues which employ words and ways of knowing specific to the trade such as Electrical or Automotive Engineering contexts. In addition, the students are adults who bring their learning of previous work and their learning experiences and knowledge to the environment including notions of how to socially engage and interact with others through utterances. Taken together, these provide additional opportunities for the physical mediation of the activity conducted. Whilst Alexander's work provides excellent tools or repertoires about how to employ different forms of learning talk, class organisation, groupings, and strategies used to extend critical thinking and problem-solving, it does not specifically address the mediational effects of the materials and tasks and their role and impact in those dialogues. However, since Alexander's approach is focused mainly on the socially constructed aspects of the classroom talk and the talk itself, it is useful in understanding the dialogic elements accompanying the activity conducted for this research.

2.2.5 Thinking together

Another highly influential approach to dialogic education is the Thinking Together programme, designed as a two-stage study (Dawes, Mercer, & Wegerif, 2000; Dawes et al., 2004). The first stage was designed to promote effective classroom discussion and collaboration. The second stage, designed from findings from stage one, was delivered as a trialled design to students. Developed by

Dawes et al. (2004), this programme has since been evaluated in studies conducted in the UK, Mexico, South Africa and China (Phillipson & Wegerif, 2020). First, researchers identified the types of talk commonly found in primary classrooms and named them as “disputational talk, cumulative talk and exploratory talk” (Dawes et al., 2004; Littleton et al., 2005, pp. 167-170). Disputational talk came to be described as an unproductive disagreement. In essence, *disputational talk* consists of an initiation, followed by a challenge, within a group discussion. Typically, this type of talk ends in no clear solution or any shared understanding amongst participants. *Cumulative talk* is described as a type of talk in which students build shared knowledge by “…repetitions, confirmations and elaborations” (Littleton et al., 2005, p. 169). *Exploratory talk* is described as talk in which students jointly engage and build mutual understanding through explicit reasoning, justifications, and solutions. Littleton and colleagues (2005) hypothesised that exploratory types of talk were more likely to engender learning and hence this type became the main focus of Key Stage 1 in the Thinking Together programme (Littleton et al., 2005). Following their study, the researchers developed a “Talk Box,” or toolkit of ground rules to teach students how to talk together more effectively in groups. It included ground rules such as being respectful of the opinions or views of others, and after all information was shared, reasons and justifications were provided and the group collectively sought shared understanding and agreement (Littleton et al., 2005, p. 171). To analyse the small-group discussions the researchers focussed on key words/phrases such as “because or ‘cos,” “I think,” “why,” “which,” “what” and “you” and found that the frequency of these words increased dramatically following an intervention using the Talk Box (Littleton et al., 2005, p. 179). Whilst their research was undertaken in a primary school setting, the present study shows that similar types of talk emerge in the tertiary trade’s educational environment. In addition, the components or modalities of these discussion types can be reframed and analysed as forms of talk which indicate or accumulate into shared meaning such as shared knowledge, shared inquiry and reflection based on an activity, and the mediating effects of the artefacts employed.

2.2.6 Dialogic space

Drawing upon Bakhtin's (2010a) notion of the *insider–outsider* and Buber's (1970) concept of the *in-between*, Rupert Wegerif (2013), described the influential concept of *dialogic space* in a modern context. Dialogic space may be conceived of as an expanse within which dialogues merge and emerge between participants, situated within physical and digital realms. Wegerif (2013) argued that the internet age is shifting dialogic pedagogy from traditional verbal and textual communication to spatial communication which can occur simultaneously at the local and global levels. That is, education is no longer bound to the temporalities of time nor to geographical space. Dialogic space is connected to spaces and people, seen and unseen (Wegerif, 2013). Wegerif offered many examples of possibilities, where dialogic space is contextualised, such as solving logic problems together and as ways in which visuals (such as icons) can provide assistive prompting. Wegerif argued that online dialogic teaching "needs to focus on opening, widening, deepening and resourcing dialogues" since the breadth and depth of resource and discourse available through the internet is exponential and can be used at any time (Wegerif, 2013, p. 108). Whilst Wegerif touched upon the use and need of resources available digitally for students in local and global contexts, dialogic talk remains the primary activity and resources remain subservient to their use. I, on the other hand, argue that resources or materials impact and mediate the dialogues regardless of the modalities of space used for mediation, such as the internet, a face-to-face practical session, or a student using a schematic diagram. Broadly speaking, I take a more expansive definition than Wegerif's, highlighting the inclusive nature, and the mediating effect, of materials and activities.

2.3 Blended Learning Environments

According to the New Zealand Ministry of Education's statistics website, Education Counts (2020b), student attrition rates in trades education have steadily increased yearly since 2014 (Ministry of Education, 2020b). Wheelahan and Moodie (2017) have suggested that the structure of the qualifications or courses are not meeting requirements in the job market or that the courses are not providing students with opportunities to engage with their course content and materials. The EDUCAUSE Horizon Report, Teaching and Learning Edition (2020) suggests that BL designs provide opportunities for students to revisit classroom experiences and engage in multiple learning opportunities in digital and physical environments (Brown et al., 2020). At tertiary level, BL environments are perceived as contributing to student learning experiences. Flexible learning environments that combine digital and material resources with face-to-face instruction are the focus of this research, which aims to investigate the design of BL environments at Unitec, a vocational training institution that has prioritised BL courses for the delivery of vocational training.

Since the advent of digital technologies, the nature and delivery of traditional tertiary classroom teaching and learning has changed. Traditional face-to-face instruction techniques with lectures and tutorials have been shifting to those that are more interactive, involving a blend of online, face-to-face, and hybrid situations (B. Alexander et al., 2019; Becker et al., 2018; Brown et al., 2020; Spring, Graham, & Hadlock, 2016). BL environments may include different media such as web-based audio and video, web-based discussion boards, discussion forums and is usually delivered in modules of learning (B. Alexander et al., 2019; Becker et al., 2018; Brown et al., 2020; Milanese et al., 2014). Brown et al. (2020) and Vaughan (2007) have emphasised that a BL approach provides opportunities for increased interaction amongst students and teachers, flexibility in the environments used, and potential for increased student engagement. A BL environment is one in which a student learns from a *blend* of in-class and online environments, where in-class and online may also involve students using a mix of digital technologies. As examples, students access a YouTube video or use a Learning Management System to complete an online quiz or may research a particular topic on Google. An online or digital environment may be used synchronously or asynchronously, the latter offering some control over time, place, and pace of learning (Means, Toyama, Murphy, & Baki, 2013).

The 2020 EDUCAUSE Horizon Report – Teaching and Learning Edition (2020) reports that face-to-face, online learning and BL in tertiary institutions continue to trend as high priority for many academic institutions internationally. EDUCAUSE's report refers to numerous advantages to BL, including the capability of enhancing the learning experience to provide more opportunities for dialogues between students and lecturers by facilitating access to a wider range of resources than what would be available in traditional classrooms. BL supports engagement and provides more flexibility and responsiveness in instruction (Rowe, Frantz, & Bozalek, 2012). Digital technologies therefore provide opportunities for changing the physical configuration of a traditional classroom layout, in which the instructor no longer needs to lecture students at the front of classroom with students in well-ordered rows of individual desks (B. Alexander et al., 2019; Brown et al., 2020; Rowe et al., 2012). The BL environments involved in this research include a blend of digital and physical spaces in a learning context with provision of a variety of learning activities.

2.3.1 BL in vocational settings

There appears to be strong industry support for BL for a variety of reasons. Callan et al. (2015) interviewed 21 teachers, programme managers and directors of vocational education institutions in Australia and reported that a major driver of the growth in BL courses in the vocational sector was that employers wanted more affordable training that could be delivered in a flexible way – not simply in the classroom but in the workplace and beyond. Employers wanted more work-based training, less time off the job for their apprentices, and shorter completion times. In relation to allied health professionals, Milanese et al. (2014) reported that BL had gained popularity but "there is still little evidence to support this trend" (p. 87). Their review of the literature revealed that 35 studies out of 184 identified showed weak evidence regarding improved outcomes, when compared with other models, such as e-learning alone or face-to-face teaching. Although BL was deemed to be more effective than e-learning or traditional learning on its own, the effects were mostly in terms of student knowledge acquisition and satisfaction but in other respects, the effects were considered modest. The authors argued that key elements of successful learning for any form of education, whether e-learning, face-to-face instruction, or BL were threefold: student engagement and communication with peers; flexibility of learning options for students; and adequate support mechanisms from tutors (Milanese et al., 2014). They also suggested that effective e-learning should be easy to navigate; should engage participants; give opportunities for students to interact with peers; give feedback and coaching; and offer a range of learning opportunities such as problem-based learning, case presentations, synchronous discussions (Milanese et al., 2014).

Nore (2015) reported a longitudinal study that followed 115 Norwegian students through three different trade certification journeys from secondary school through to graduation. One of the study's findings was that different stakeholders involved in the trades training, namely, government regulatory agencies, training organisations, and third-party curriculum developers, held different conceptions of BL (Nore, 2015, p. 188). A similar diversity of views about BL was reported in a phenomenological study at a large Australian vocational education provider, which involved interviews of 81 teachers (Bliuc et al., 2012). Biluc and colleagues (2012) revealed that teachers' conceptions and understandings of BL and course design varied greatly. A cohesive understanding of what constitutes BL for trades instructors and trades employers remains elusive.

Over fifteen years ago, Elliott and Clayton (2007) investigated the perceived costs and benefits of introducing e-learning activity into New Zealand Industry Trade Organisation's programmes and found that BL offered more opportunities in flexibility for course delivery and in timing. This finding highlighted a significant benefit for businesses of apprentice and employed students as it decreased the amount of required in-class time, enabling less time off work (Elliott & Clayton, 2007). More recently, Nore (2015) found students were able to document their skills and tasks through creating videos with their own devices while on site at work and for assessment and skills evidence for potential employers. She found that students used video as tutorials for clarification of concepts and to capture what was required of them for specific tasks. This finding suggests that affordances of the technologies used within a trades BL environment enable continuing work, both off site and in the workplace for course credit.

Although research on BL environments seems to support the idea of its great potential within vocational tertiary education, questions remain about how well BL is working in these settings and whether it will deliver on its promise. Positives seem to be that it is somewhat more effective than online learning or face-to-face learning on their own: it is cost efficient from the employer's point of view relative to time off work for the employee or apprentice, and it gives flexibility in terms of learning opportunities for learners. As we will see in the next section, students appear to respond better to a BL environment, which is likely to contribute to more effective learning.

2.3.2 Student perceptions of blended learning

Student perceptions of BL seem to be important for determining the success of a BL course. Ginns and Ellis (2007) surveyed a group of 127 veterinary science students in Australia and found that students who failed the BL course spent less time in the group and communications part of the course website. Students who had positive perceptions of the online teaching and level of interaction were more likely to achieve higher grades. They found that moderation of postings and encouraging interaction among students was associated with students liking the course better and with better grades. So and Brush (2008), in a survey of 48 graduate students in health education, found that students who thought there was a higher level of collaborative learning were more satisfied with the course. López-Pérez, Pérez-López, and Rodríguez-Ariza (2011), in a survey of 1431 accounting students at the University of Granada, found that BL reduced dropout rates and improved examination marks after its introduction into course designs. They also found that students had positive perceptions of BL. BL courses, which use blogs, wikis and forums and other digital tools, can effectively provide peer and instructor support while simultaneously providing multiple tools for course engagement (López-Pérez et al., 2011). Miyazoe and Anderson (2010) assessed student outcomes and perceptions in an English as a foreign language (EFL) course for teaching writing that provided students with forums, blogs, wikis, and written dialogic tools for students to practice and hone their English skills. They found that students were positive and engaged in the BL environment.

Similarly, Wang, Chen, Tai, and Zhang (2019) found that BL is beneficial for English as a first language course delivery and that students' perceptions overall were very positive of this approach. The researchers found that BL course design enabled student self-directed learning, augmented face-to-face interactions by complementary online resources, increased self-awareness of learning autonomously, and provided a participatory and supportive environment (Wang et al., 2019). In addition, Bouileres and his colleagues (2020) studied the perceptions of students about their redesigned BL courses. The results showed that, although BL did increase students' interaction with instructors, it did not necessarily increase their interactions with fellow students (Bouilheres et al., 2020). In addition, students agreed that they benefited by the activities offered in the BL environment and that it offered anytime access to course content. Overall, the students perceived the BL experience as a positive one although the researchers found they could better support student-to-student interaction in the environment (Bouilheres et al., 2020).

To summarise, students have positive perceptions of both components of BL, not only online learning but also face-to-face instruction. A significant determinant of their positivity is the extent to which they engage with the BL environment. Encouraging students to communicate with each other online and moderating the discussions seem to contribute to their positive perceptions. BL appears to have advantages that face-to-face instruction does not have in that students are able to revisit the content material online, interact with the tutor and fellow classmates online as part of their learning and take advantage of the many benefits of the online space such as videotapes of lectures and tutorials, blogs, websites, and discussion forums. The extent to which students take up these opportunities, and how well they engage with them, appears to vary from course to course and depends very much on the ways in which the BL course is designed and delivered. While most students do engage with BL environments, some do not, and it is not clear why this is so. Several studies reported in this review of the literature have concluded that there is still much to learn about how well students are able to manage the requirements of a BL environment and the extent to which additional support is needed for them to take advantage of the potential learning.

2.3.3 Communities of practice, learning networks, and agency

In *Situated Learning: Legitimate Peripheral Participation,* Lave and Wenger (1991) describe learning as a social practice connected within "communities of practice" and bound by the "connectedness of knowing". Communal and individual knowledge emerge and morph within shared spaces, both digital and physical. Their work was predicated on understanding the foundations of apprenticeships and exemplifying experiential learning through the process of participatory activity. The Level 3 courses analysed for this research were designed primarily to prepare students for apprenticeships and their future within communities of practice. As Lave and Wegner (1991) argued:

> A community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage. Thus, participation in the cultural practice in which any knowledge exists is an epistemological principle of learning. (p. 198)

Learning a trade is based on cultural and participatory activity and the notion of communities of practice allows us to conceptualise particular forms of participation that contribute to very specific ways of knowing and becoming (Chan, 2013, 2020b, 2021). Blended course designs provide opportunities for instructors to plan and design for student participation, within their communities of practice as pre-apprentices and apprentices.

BL environments can also be contextualised through the notion of learning networks (Carvalho & Goodyear, 2014; Goodyear, 2005; Yeoman, 2015). A learning network, as the word *network* implies, focuses on the connections of things and people in a learning environment (Thibaut, Curwood, Carvalho, & Simpson, 2015). A learning network is defined as "…a heterogeneous assemblage of people and things connected in activities that have learning as an explicit goal or as a significant side effect" (Goodyear, Carvalho, & Dohn, 2016, p. 93). This understanding acknowledges the point that learning may occur in a multitude of contexts, incidentally, out of interest through others or in formal educational settings such as a tertiary educational institution. In addition, learning and activities in a learning network are "… mediated across agents, tools, and spaces" (Thibaut et al., 2015, p. 459).

The notion of networked learning focuses on how technologies foster "…connections between one learner and other learners, between learners and tutors and between a learning community and its learning resources" (Goodyear, Jones, Asensio, Hodgson, & Steeples, 2001, p. 7). Communities of practice differ from learning networks since they tend to focus on the humans within them rather than the connections or nodes of a learning network, human or things (Jones, Ferreday, & Hodgson, 2008; Lave & Wenger, 1991). Carvalho and Goodyear (2014) argue that networks are more fluid and open and that the individuals who participate within them do not necessarily know each other. Moreover, foundational to learning networks is the concept of movement. "Networking involves travel — of people, objects or messages. Community need not" (Carvalho & Goodyear, 2014, p. 10).

An underlying assumption is that students hold agency, and they will willingly participate within these communities. Khoo and Cowie (2018) showed, in their study on Engineering students at a university in New Zealand, that students employ different learning strategies to seek or extend their knowledge through multiple and supplementary ways outside of what was provided or designed for in their laboratory and lecture sessions. A requirement of the Engineering programme for these students was to learn a three-dimensional, computer-aided design software program called SolidWorks. Initially, it was found that students drew predominantly upon their instructor's knowledge with peers and online tutorials providing supplementary knowledge to learn the software. Interestingly, as the students progressed through their years of study, their repertoires or approaches effectively changed and extended to include other communities, such as on the internet, using Google searches and their personal networks, such as at a workplace. Student agency and initiative or the need to master the software proved to be foundational to this knowledge progression for the students and underscored their learning journeys (Khoo & Cowie, 2018).

An optimal BL design would therefore foster student agency and initiative, encourage student engagement with other apprentices within broader trades communities of practice, and enable a flow of ideas and knowledge that dip in and out of the physical and digital course context, and offer opportunities for incidental learning.

2.3.4 Flexible learning environments

Today, many classrooms across the world, including New Zealand, have been reconfigured or redesigned with flexible furniture and technologies, that can be moved, re-configured, and used to suit the different learning needs and activities involved (B. Alexander et al., 2019; Becker et al., 2018; Brown et al., 2020; Jaramillo, 2017). For example, computers with large screens on moveable stands alongside moveable, modular desks on wheels can be clustered together to support group activities or separated for individual work. The classroom space design and resources available within a new learning space may change the way teachers and students interact and engage in their teaching and learning conversations. The research of Carvalho et al. (2016) suggests that the ways in which students interact with each other using the tools available to them, both digital and physical, can potentially impact how they learn. The layout of learning spaces may contribute to enhancing (or hindering) the ways students and instructors might engage in learning dialogues based on their proximity, the social aspects of their in-class relationships, and the resources they use in the classroom (Carvalho et al., 2016; Ravelli & McMurtrie, 2016). That is, the layout of spaces, the furniture arrangements and the ways material and digital tools are used will likely have an impact on students' learning experiences.

The conversion of traditional, lecture-based learning environments into those that include newer technologies and mobile seating arrangements offer facilitated flexibility, mobility, and the use of multiple devices. This study will look at the extent to which such environments encourage a different kind of learning. Flexible learning environments (FLEs), with their unique configurations, can be customised to suit purpose, enable teacher flexibility, and provide opportunities to create and revise BL course design. Physically moving and reconfiguring seating arrangements may change the activity and communicative experiences of the students (Carvalho & Goodyear, 2014; Carvalho et al., 2016; Goodyear et al., 2021; Ravelli & McMurtrie, 2016).

As such, classroom spaces play a role in how teachers design for learning and how course work is delivered (Benade, 2017; Charteris, Smardon, & Nelson, 2017; Ministry of Education, 2016; Organisation for Economic Co-Operation and Development, 2021). Characterised by large open spaces, FLEs are designed to offer opportunities for multiple cohorts or groupings to co-exist and participate simultaneously in learning activity (Benade, 2019; Ministry of Education, 2016). Research on FLEs tends to focus on the teacher's practice and students' experiences of these environments either in schools (Benade, 2019) or in university settings within higher education (B. Alexander et al., 2019; Becker et al., 2018; Bisset, 2014; Brown et al., 2020). However, research on open plan trades environment in the tertiary setting remains minimal.

Mataaho, New Zealand's largest open plan trades training building at Unitec, and the main data collection site for this research, was designed to be configurable and modular to reflect "…a modern worksite with many (trades) disciplines within close proximity…." (Unitec, 2017, para. 8) Mataaho is intended to emulate the environmental experience of being a trade apprentice on site such as a housing development with electricians, builders, and plumbers co-situated. This large, open plan trades environment, however, is not as configurable and modular as primary and secondary school FLEs. Large hoists, electrical workbenches, plasmas cutters, welding bays, and other materials and resources need to be tethered due to size, electrical, safety and machinery requirements rendering at least a portion of the space(s) fixed, stationary and unmoveable. In addition, other environmental conditions, such as sounds and smells, may also impact the student experience (Chan, 2021). However, there are some spaces within Mataaho that offer flexibility for students to configure, such as the moveable Engine blocks in the Engine Assembly/ Reassembly area or the breakout rooms with moveable furniture situated at the perimeter of the building.

In a recent study about learning spaces within vocational educational and training environments (VETs), Rintala and Nokelainen (2020) pointed out to the need for a fine balance between trades education environments and work environments for improved student experiences. A trades training environment should emulate the work environment as much as possible, and VET was considered more attractive to potential students if there were links between work place environments and quality educational environments (Rintala & Nokelainen, 2020). The authors' analyses of four interview data sets found that VET education providers might consider feedback from business and external stakeholders to inform future VET learning designs (Rintala & Nokelainen, 2020). Whilst this study touches upon the importance of emulation of the workplace within the educational environment, it does not explicitly seek to provide recommendations for an in-class environment, open plan or otherwise.

2.3.5 Bringing together blended learning, materials, and dialogic spaces

BL environments provide ample opportunities for the use of artefacts both digital and physical. In the article, "The role of digital artefacts on the interactive whiteboard in supporting classroom dialogue," Sara Hennessy (2011) provided an account of how the physical and digital affordances of interactive whiteboards facilitated and opened up dialogic spaces (Wegerif, 2013) used by students and teachers within a school context. Selected case studies connected dialogic pedagogy with the mediating aspects of the artefacts used, in this case interactive whiteboards. Based on the notion that "we think with and through artefacts," the researcher drew upon multiple examples from different secondary classrooms including Science, History, English, and Personal Safety in the UK (Hennessy, 2011; Säljö, 1995, p. 91). Hennessy (2011) found that interactive whiteboards provided opportunities for exploring, connecting, comparing, contrasting, and identifying the strengths and weakness of ideas that students can simultaneously co-construct and interact with them. The study also found that the interactive whiteboards provided opportunities for co-construction of both artefacts and dialogues—key ideas in dialogic education and socio-material assemblages. The significance of her finding to this research is that digital artefacts along with co-constructive talk produced opportunities to "broaden and deepen classroom dialogue" (Hennessy, 2011, p. 484).

Moate et al. (2019) reported on the mediating effects of sketchbooks in teacher education. Student teachers were asked to use reflective sketchbooks to explore educational theory and practice, in which they self-selected pages to submit once their course was completed. Researchers analysed and found that visual depictions or drawings of eyes (e.g., awareness or engagement), words in the form of questions (e.g., questioning practicalities of theory) and pathways (e.g., paths, rivers, walkways, and arrows) appeared frequently in a significant portion of submissions (Moate et al., 2019). Individual expressions also surfaced through theoretical references, graphics, organisation of concepts, aesthetic designs, personal reflections and notations (Moate et al., 2019). The researchers found that the reflective sketchbooks provided visual and textual examples of reflective dialogues on theory and about others and their individual thinking. It concluded that the modalities of use by the students highlighted the importance of the materiality of the sketchbook as mediators to students' thinking and expressions about educational theory and practice (Moate et al., 2019).

Hetherington et al. (2018) conducted a critical literature review of science classroom research to identify how materials and scientific dialogues were conceptualised and employed. The researchers found that much of the literature is underlined by theories about constructivist and spatial-constructivist areas of learning which typically separate out learning from the practical uses of the materials employed. They also identified that current dialogic theories focus on the verbal forms of dialogue and ignore the interaction with objects and the material world (Hetherington et al., 2018).

Their findings identified that practical work in science classrooms all over the world is significantly important to gain insights into how science is constructed. They also emphasised that the use of materials for practical implementation, as well as the use of materials as pedagogical tools such as worksheets and maps, commonly occurred alongside collaboration and discussions (Hetherington et al., 2018). As to the relationship between practical work and classroom talk, the researchers found that science requires argumentation based on evidence and that the dialogically led discussions and modelling by the instructors played a significant role in opening the dialogic space for classroom talk. Material interactions were also found to be pervasive in the science classrooms, including the embodied experiences of cognitive, emotional, and physical experiences of students in the classroom. Physical models, gesturing on behalf of the participants, interactive whiteboards, physical and virtual environments or materialities, and laboratory equipment all mediated the dialogues that arose across their review of literature (Hetherington et al., 2018).

Hetherington et al. (2018) found that constructivist explanations, with a focus on disembodied concepts, were bereft of accounting for the material nature of the laboratories and science classrooms. They drew upon dialogism and Barad's (2007) agential realism to propose and describe a material-discursive theory (Hetherington et al., 2018). For Barad (2007), matter and meaning are mutually constitutive (p. 152). Matter and meaning are entangled, produced through relations that occur and co-emerge through “intra-actions”. That is, for the researchers, the dialogues and engagement with the materials in the science classroom are inclusive of each other in their activity.

Similarly, Cook et al. (2019) conducted a study on the use of a microblogging tool with the material-dialogic approach for geography classrooms. Their aim was to incorporate the “voices” of the materials used to engender talk and those of the study participants (Cook et al., 2019). Data were drawn from six geography lessons in two UK schools using the micro-blogging tool called Talkwall. The tool enabled students to share and build upon each other’s ideas which are visible either to all students or to a sub-group of students (Cook et al., 2019).

The researchers documented rich descriptions of episodes or communicative events and students’ actions to apply material-dialogic theory. They found that the consideration of the material and the dialogic deepened understanding for students. In particular, the authors highlighted the way in which the simple act of positioning a blog post on the wall (digitally moving it or pointing at it physically while looking at it on the computer) in relation to the others, while engaged in robust discussion, provided an example of how the boundaries between the material and dialogues were blurred (Cook et al., 2019). This study showed the mutual mediating effects of the materials and dialogues and their importance to the learning experience.

2.3.6 Dialogues and activity

What we do as humans is inevitably mediated by what we say. Wells (2007) suggests that the object of action takes a transactional, mediating form through discourse and that discoursing is not an activity in its own right but “an operation using linguistic resources” that enables the co-construction of the action (Wells, 2007, p. 17). That is, action is object-oriented and includes linguistic aspects of discourse. Even though humans are accustomed to using language through utterance, it remains a tool. While Wells privileges the discourse as a linguistic tool over the activity, he maintains that both impact each other. However, Wells emphasises the importance of activity and sequencing in combination with discourse.

Another relevant research study in this area analysed the dialogic patterns that emerged from within an inquiry-lead, project-based, Earth Sciences course in an American high school, using an *activity structure* to contextualise and describe the structure of dialogue sequences (Polman, 2004, p. 435). His approach perceived each structure containing dialogic elements (Bakhtin, 2010b; Polman, 2004; Wertsch, 1991), with structures considered as domains or containers to describe the dialogic interactions amongst his study participants. As part of this case study, students were asked to formulate a research question, provide evidence to address the research question, analyse the data and report findings, whilst Polman videotaped the teacher and two student participants working together on a project for a 10-week period. The findings suggested that two activity structures at two different time scales supported the students' projects (Polman, 2004). The long-term time scale, the 10-week project, enabled a synergy of artefacts provided by the instructor at each stage of the project, which allowed students to co-construct their final science research report. On a short timescale, Polman identified the repetition of student-led, action-negotiation dialogues and questions, and teacher feedback dialogues that enabled students to maintain agency and engagement in their project. Action negotiation dialogues are learning dialogues in which students negotiate with each other and their instructor, aspects of their project activity. Student questioning dialogues were those involved with inquiring amongst themselves or with the instructor to clarify their understanding. Action feedback dialogues are teacher-led. Each dialogue structure described the overall nature of a dialogue identified in this study and their role in the activity of this science-based project, not components of dialogues which may be conducive to or enable activity (Polman, 2004).

Polman's (2004) approach relied heavily on the structure of the course to determine how the dialogues emerged over time. Since the instructor participant was guiding students through questioning techniques, he was simultaneously modelling the kind of thinking he wanted his students to conduct to achieve scientific results based on evidence. Again, the role of the material aspects and individuals called upon to provide input to the students' work, were considered secondary to the importance of the role of talking about the strategies and the project activity.

In 2018, Major and colleagues conducted a seminal scoping review which identified and analysed 72 studies, across 18 countries focused on classroom dialogues, dialogic pedagogies and digital technology. They analysed the studies based on two research questions: (1) In what ways does research suggest that the use of digital technologies enhance productive classroom dialogue; and (2) What challenges are reported that may impact on the successful use of digital technology to support dialogic teaching and learning? Multiple themes emerged and, in particular, for research question (1), the researchers identified a significant theme called "dialogue activity" (Major et al., 2018, p. 2005). They found that dialogue activity could be listed into four sub-themes including: how digital technology promotes exposure to alternate perspectives; how digital technology can support students in purposeful and sustained knowledge construction; how digital technologies provide opportunities for meta-cognition or reflective dialogues; and how students use knowledge to build the knowledge of their peers (Major et al., 2018). The significance of the exercise is that it acknowledges the interactional and mediational effects of the learning dialogues and digital technologies in learning settings. In addition, it provided a comprehensive overview of the current research landscape of learning dialogues and digital technologies in primary and secondary learning environments.

2.4 Conclusion: Making a Case for Dialogic Activity

Dialogic education provides a framing for understanding the types of talk or learning dialogues that extend students' thinking and problem-solving skills. While the bulk of dialogic research focuses on primary and secondary schools and science education contexts, it remains an emergent field in tertiary education and in the tertiary trades environment. Vocational or trades education relies heavily on tools, both physical and digital. A deeper understanding of the BL context of the trades training environment requires attention to both mediational means and the qualities of the materials and artefacts in use alongside the emergent learning dialogues.

It is within this space that I situate this research to seek insights into dialogic activity, and how material and digital tools or artefacts impact dialogic activity and students' perceptions of them. It is hoped this research will shed light onto ways that dialogic activity may provoke positive impacts to student perceptions about learning within BL environments.

In pre-apprentice trades training, the foundational technical skills and trade-specific talk must be learned to enter a full apprenticeship. Dialogic models or repertoires can be applied to these contexts to guide students' shared thinking to solve problems. All educational dialogues or types of talk are typically intended to scaffold students into language and knowledge levels appropriate for them to be "job ready" for their apprenticeships. In Bakhtinian terms, they are described as language "genres" (Bakhtin, 2010b). As the literature suggests, initial types of talk in the trades environment may include IRF–IRE exchanges led by instructors when rote memorisation is required – like mathematical formulae or trade-specific vocabularies. Eventually, the instructors will draw upon their teaching tools or repertoires including questioning techniques aimed to engender student engagement and to extend their problem solving and critical thinking. The body of research conducted under the umbrella of dialogic education, including dialogic teaching (Kim & Wilkinson, 2019), Alexander's (2020) A Dialogic Companion, the thinking together project (Dawes et al., 2004), and Hennessy's (2011) work on the mediating effects of interactive whiteboards and students' learning dialogues provide many key approaches and concepts useful for analysis or explanations of tertiary trades learning talk or dialogues. In addition, Wegerif's (2013) concept of dialogic space is key to understanding the interplay of learning dialogues and activities and how they come into existence. For this research, learning dialogues are those which occur in dialogic spaces and may be identified through shared knowledge, shared inquiry, and reflection.

Dialogic education, however, appears to privilege ways of teacher modelling and dialogic stance, ways to extend students' thinking verbally and problem solving mainly through talk, as well as student groupings, without much consideration of what the students are doing alongside their learning dialogues, the materialities involved, and how students perceive these interplays at hand.

In this research, I contend that joint consideration of students' activity and their dialogues may be captured in the term, dialogic activity. Dialogic, in dialogic activity describes utterances of shared knowledge, shared inquiry, and reflection (both uttered and not) while activity, in dialogic activity acknowledges student agency and situated experiences with artefacts both digital and physical within the context of the dialogic space, the ecosystem of the learning environments. Dialogic activity acknowledges the doing alongside the shared utterances and reflective acts experienced in multiplicity within the dialogic space held within the learning environment. It is this thinking which has led me to the following research questions for an investigation into dialogic activity in a tertiary trades environment:

- What dialogic activity emerges in a blended learning environment?
- How do material and digital artefacts in BL environments impact on dialogic activities?
- What are students' perspectives of dialogic activity in a BL environment?

3 Theoretical Review

3.1 Introduction

Understanding learning activity within the context of BL may be a complex endeavour since learners in those environments are often required to navigate across multiple physical and digital domains. Learning how to design for BL is, therefore, important for optimal student learning and outcomes. For this research, BL is defined as any combination of traditional and e-learning approaches; it may include different tools and media and be delivered in modules of learning in a variety of ways (Milanese et al., 2014; Spring et al., 2016). BL assumes that interaction between people is mediated by digital and physical materials, for example laptops, drills, mobile phones, pens, paper, machines, online course content, discussion groups and assignments (Carvalho & Yeoman, 2019; Goodyear et al., 2016; Yeoman, 2015). However, as Carvalho and Goodyear (2014) have noted, the boundaries between the digital and physical aspects of a BL environment are often challenging to define.

Drawing on an interdisciplinary theoretical approach, this research explores learning activity within complex spaces that blend the digital and physical through the lens of learning entanglement, with a focus on the learning dialogues that emerge within physical and digital domains (Hodder, 2012; Repko & Szostak, 2020). As such, the research argues that activities in these environments should be understood, not only in connection to what students do, but also in relation to their learning dialogues. This research explores the activity that arises from BL environments, and associated learning dialogues, from two unique perspectives which, when taken together, offer opportunities to gain insight into learning activity.

This study draws upon the theories of entanglement (Hodder, 2012) and dialogism (Bakhtin, 2010a). In so doing, I propose the term, dialogic activity, which will be used throughout this study. In this chapter, I will describe concepts from entanglement theory, which I use in later chapters to explore the connections between participants and both digital and material elements from within a learning entanglement. Second, I describe the ACAD framework as the analytical tool used to frame this interdisciplinary approach (Goodyear et al., 2021). Third, the theoretical underpinnings for dialogism and concepts used to gain insight into the learning dialogues that transpire within those contexts, will be explained. Finally, I describe what is meant by dialogic activity.

3.2 Social Materialism in Education

Social-materialist approaches to educational research regard the relationships between human and materials in learning environments as jointly connected; that is the material and human aspects of a learning environment are important to consider when conducting a study of learning. Fenwick, Edwards, and Sawchuk (2015) argue that social materialist research is a vast research domain and covers a wide variety of approaches including complexity science, cultural historical activity theory (CHAT), actor network theory (ANT), and spatiality theories (Dewey, 1986; Fenwick et al., 2015; Latour, 1996, 2005; Vygotsky, 1962). Each approach focuses on different aspects of the relations between humans and things within a learning environment. For example, complexity science considers the role of emergence as central and binding amongst relations between things and humans (Fenwick et al., 2015; Laidlaw, 2005). Whereas CHAT focuses more on the social-cultural aspects of humans in relation to the materials in the learning environment (Dewey, 1986; Fenwick et al., 2015; Vygotsky, 1962). ANT focuses on the interactions that occur between humans and things and spatiality theories consider the role of space to be crucial in the mediation of relationships amongst humans and things in a learning context (Fenwick et al., 2015; Latour, 1996). Each approach is unique, yet each acknowledges that the relationships and participants in the learning process are complex.

One emergent approach is Karen Barad's (2007) agential realism which draws upon contemporary quantum physics to describe and explain the intra-action of elements within the social in learning contexts (Barad, 2007; de Freitas, 2016). Her book, *Meeting the Universe Halfway* (2007), has become increasingly influential in social sciences and humanities research (de Freitas, 2016). Trained as a physicist, Barad (2007) draws upon approaches from scientific contexts with laboratory experiments to illustrate that matter and meaning are entangled and, based on their relations, matter and meaning co-arise through simultaneous activity. Barad observes that matter in the world is not bound by properties or materials. Rather, matter continuously flows and is temporarily bounded by performance through their intra-actions. Both embodied humans and non-humans contain the agency to act upon each other in material-discursive processes to make *agential cuts*. These agential cuts are made through *apparatuses*. Barad contends that a photon's position *or* momentum can be measured, but not both simultaneously. The agential cut is made by the apparatus (laboratory equipment) which provides meaningful measurement of the position or momentum of the photon. Applying these ideas to social science research, the role of the apparatus may be abstracted to include insights into activity or practices that re-configure activity between the human and the non-human. For example, in an Electrical Engineering workshop, the students, teachers, electrical equipment, pens and papers, and digital and physical tools are all entangled. Meaning develops and phenomena occur when the human and non-human participants intra-act. The agential cuts occur when one agent acts upon another, such as when a student mis-wires the circuitry board, causing the control switch to fail.

Estrid Sørensen in her work, the *Materiality of Learning* (2009), suggests that learning is embedded with the material aspects of a classroom. Materials are not mere instruments in learning, but consist of material objects that are distributed within the social and physical aspects of the learning activity (Fenwick et al., 2015; Sørensen, 2009). The point highlighted is that learning is embedded within activity, not alongside it. Ian Hodder's (2012, 2014) entanglement theory acknowledges Sørensen's notion of embedded activity to emphasise the temporalities and sequencing of events within a social-materialist context. By identifying phenomena as entanglements, Hodder provides a formulaic structure to highlight the dependencies contained within them. Whilst Barad's theory acknowledges the complexity of a learning entanglement, it does not highlight the importance of the timing or sequencing of events within a specific entanglement. Nor does it highlight the nature of the dependencies of an entanglement. Therefore, for this research, Hodder's (2012, 2014) entanglement theory was chosen as the social-materialist theory to underpin this research and is described in detail in the section that follows.

3.3 Entanglement Theory

Entanglement theory is used to describe a complex situation or scenario comprising multiple materials, individuals and activities conducted in a specific context. Entanglements are understood as open-ended phenomena and are never complete; they entail configurations of humans and things and their dependencies or co-dependencies exerted upon each other (Hodder, 2012). Entanglement theory provides social-materialist insights into the dependencies between humans and things in any given entanglement (Hodder, 2012, 2014). With its origins in the work of Ian Hodder (2012), the theory has an established precedent for use within educationalist research (Carvalho & Yeoman, 2018, 2019; Yeoman, 2015; Yeoman & Carvalho, 2014).

Consider the following example of a student using a drill to manufacture holes into a metal plate in a workshop setting. The drill itself is composed of multiple parts including a drill bit, a sharp metal rod that removes material to make holes. The drill bit may deteriorate, snap, or become dull over time and it must be replaced or sharpened periodically for students to be able to use it for project work. Students are dependent upon the drill bit being well maintained or prepared for in-workshop use; this creates a dependency between n the students (the humans) and the drill bit (the thing). Through the notion of entanglement, it is possible to describe the nature of dependencies which, in this case, would involve a student and the use of a drill bit to complete a required project.

Hodder's theory of entanglement (2012) suggests the use of acronyms to abstract the complex array of dependencies possible. For example, *Humans depend on Things* (HT), *Things depend on other*

Things (TT), *Things depend on Humans* (TH) and *Humans depend upon Humans* (HH) (Hodder, 2012). In the above example, the drills in the workshop environment will need to be cared for and maintained. This relationship can be expressed through (TH) to highlight that the drill (T) depends on a student or instructor (H) to care for it. Similarly, a student (H) depends on the drill (T) as a tool to perform a specific task (HT). The drills depend on other things to function; for example, drills (T) need power in the form of batteries or electricity (T) to work (TT). These dependencies highlight the importance of understanding the intricate relationships in a BL scenario, which is connected to what Hodder describes as "sticky entrapment" or the complexity of the relationships involving humans and things (Hodder, 2012, p. 94). Dependence amongst humans and things may be described as "productive and enabling" such as the battery enabling the student to drill a hole (Hodder, 2012, p. 18). However, they may also be described as "constraining and limiting" such as a dull drill bit preventing the student from drilling a hole (Hodder, 2012, p. 51).

In Hodder's (2012) theory, a total entanglement is created by the combination of the humans and things and their *fittingness* or suitability to an entanglement. As a conjunctural event occurs, it leads to a problem for which a solution is then devised (Hodder, 2012). The conjunctural event disrupts the activity, resulting in a problem which requires a solution (Hodder, 2012). The fittingness describes the suitability of the humans or things involved in an entanglement. In a learning scenario, consider the following example. Students were watching a teacher presentation which used an overhead projector. The lightbulb in the overhead projector burned out. The event, which is known as the conjunctural event, led to a problem; the overhead projector no longer worked, and the teacher could no longer project ideas for discussion. This event disrupted the lesson. The teacher must find a solution, for example by either replacing the lightbulb or using paper and pens. The conjunctural event describes the decisive moment of the event. The fittingness describes the suitability of the participants involved in the entanglement, such as the projector light bulb and the instructor in this example. Hodder's theory acknowledges the temporalities or sequencing and order of the occurrences and the activity that surrounds and emerges from a conjunctural event. That is, the burnt-out projector lightbulb is part of an entanglement, and because it was not working properly, it generated disruption from which a problem arose, and a solution was needed to be found.

Hodder (2012, p. 217) illustrates these concepts through a formula for total entanglement (***E'***) in which the → symbol means *leads to*:

Entanglement + Fittingness + Conjunctural Event → Problem → Solution → E'

Entanglements assemble and disassemble. They are heterogenous, may last a long time, or may dissipate quickly. They may also exist within larger entanglements (Hodder, 2012, 2014). Importantly, Hodder's work focuses on the dependencies and mitigating effects of the dependencies, sometimes constraining, amongst the participants in the entanglement. Constraints go beyond their meaning in any given entanglement. That is, a burnt-out light bulb changed the course of the lesson since the teacher was forced to choose a different way to create an image for students to view.

In this research, I use Hodder's ideas to map out the complex array of elements in a learning situation and to unveil their influence on learning activity. The entanglement theory formula is used to identify and describe learning entanglements analysed for this research in combination with the ACAD framework (Carvalho & Goodyear, 2014; Goodyear et al., 2021). ACAD will be used to frame the components that contribute to entanglements and to observe the emergent learning dialogues (Carvalho & Goodyear, 2014; Carvalho & Yeoman, 2019; Goodyear et al., 2021). See Figure 1 to view learning entanglements nested within the ACAD framework.

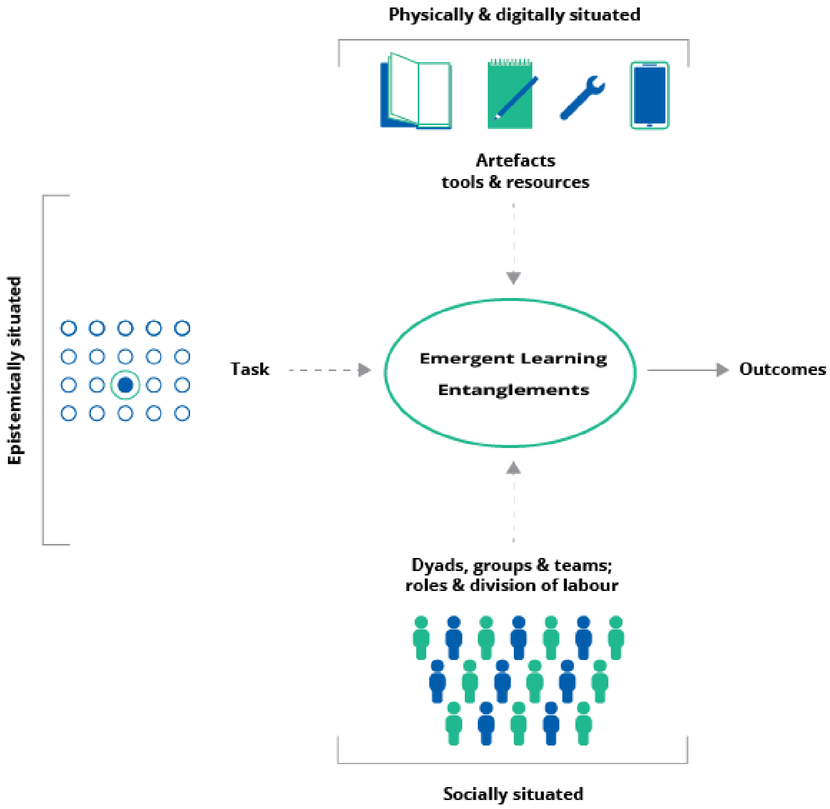


Figure 1. ACAD framework with emergent learning entanglements. Adapted from Goodyear & Carvalho, 2014, p. 59 and Hodder, 2012, p. 217.

3.4 ACAD Framework

The ACAD framework was originally created to assist educational researchers to analyse complex learning situations and to support instructors and designers with course design and development (Carvalho & Goodyear, 2014; Goodyear et al., 2021). Its structure allows the identification of designed course elements, including humans and things, which establish environmental conditions for student activity in a learning context. It is organised into four specific areas, *set design*, *epistemic design*, *social design* and *co-creation* and *co-configuration activity* (Carvalho & Goodyear, 2014; Carvalho & Yeoman, 2018, p. 1126; Goodyear et al., 2021). The set design includes the physical and digital structures through the provision of materials and resources, or digital and material elements required for use in the learning environment, such as a learning management system or pens and paper, a drill, or equipment, or specific furniture arrangements in a physical space. Epistemic design refers to the learning tasks and sub-tasks, or design work such as quizzes or worksheets. It also refers to types of knowledge and ways of knowing that are pedagogically informed. Social design refers to the social arrangements and organisation of the students in a learning context, whether students work in groups or pairs, if and how students sit together, and if they have prescribed roles for group work or within the environment. The final area is where co-creation and co-configuration activity may emerge from the interactions of students with the assemblage of elements formed by the convergence of elements in set, epistemic, and social designs. Tasks (epistemic), social arrangements (social), and tools and resources (physical and digital) may be designed, whereas emergent activity can not. Emergent activity accounts for student agency or choice in terms of how a student chooses to engage with the assemblage of elements in epistemic, social, and set design in the learning context (Carvalho & Goodyear, 2014; Carvalho et al., 2016; Goodyear et al., 2021; Thibaut et al., 2015). It is within the emergent learning activity space of co-creation and co-configuration that I propose to analyse emergent activity and learning dialogues based on the epistemic, social, and material configurations of learning situations or entanglements.

3.5 Connections Between Materials, Embodiment, Languages and Thought

Contemporary work on learning entanglement aligns well with the ground-breaking work of Vygotsky. Vygotsky asserted that, from the very early stages of human development, humans have used tools and speech as a means to develop psychologically and learn (Vygotsky, 1997b). In his seminal work, *Thought and Language*, Vygotsky (1962) sought to highlight the importance of thoughts that drive humans to use these "psychological tools" as mediators between thought and utterances (Vygotsky, 1997a, p. 85; Wertsch, 1991, 2007). He defined the psychological tools as "…language, different forms of numeration and counting, … algebraic symbolism, works of art, writing schemes, diagrams, maps, blueprints and all sorts of conventional signs" as other physical written works that are socially situated within meaning making acts (Vygotsky, 1962; 1997a, p. 85;

Wertsch, 1991, 2007). Vygotsky focussed on how thoughts within an individual are shaped through coordination with external tools and resources.

Brinkmann and Tanggaard (2010) argued that ideas are knowledge tools that we place into action and that the world appears in the contexts of activity and social practice. The physical tools employed are an extension of thought which enable humans to transfigure the physical world (Brinkmann & Tanggaard, 2010). That is, people transform and engage within the world with physical tools and that learning in this context is an embodied experience (Brinkmann & Tanggaard, 2010). As Brinkmann and Tanggaard (2010) state, "our perceivings are functions of embodied movements and actions" (p. 248). Hyland (2019) acknowledge\ds this by arguing that thinking and doing are inseparable. Through mimesis (learning by mimicry) and kinaesthesis (learning by doing), what humans perceive in the physical world eventually resides in their activity (Hyland, 2019). Hyland states "the notion that the world is at our fingertips should remind us that fingertips are connected to hands manipulated by bodies and minds" (Hyland, 2019, p. 460).

Cognitive ecology, on the other hand, illustrates the importance of the thoughts or perceptions in-situ between individuals and their environments (Hutchins, 1996, 2010, 2014; Hutchins & Johnson, 2009). Cognitive ecology considers the connections between human perception and the properties of the world to be perceived (Hutchins, 1996, 2010). Students experience their speech, thinking, perception and actions within their environments. That is, a connection exists between their thoughts and actions. Hutchins explains that "language is a cognitive process that…includes a shared world of objects and events" (Hutchins, 2014, p. 37). Language and materials enable individuals to interface with others and the world and are foundational in learning situations or entanglements. Learning entanglements and their affordances provide an ecological context to examine student activity and learning dialogues. As such, it is important to understand the subtle difference between the materials and the materiality of things. In what follows, I highlight these differences and their connections through the notion of a learning entanglement.

The term *materials* is used to describe the physical composition of the “material world of things” employed within any given entanglement (Hodder, 2012, p. 89). For example, a titanium-tipped drill bit is made of a high-temperature-resistant steel rod coated with titanium. It is designed for drilling extremely hard materials. Multiple materials and technologies were used to manufacture the titanium drill bit. To understand materiality, consider a scenario where a student is fastening two metal plates together onto a machine. The student must source the steel plates, source a drill with the appropriate drill bit, fasten the plates together with screws and assemble them in a specific order onto the machine. The materiality or assemblage of materials and tools utilised will enable the student to manufacture the entire project. Materiality, in this case, will influence the student experience as the *surfaces* of the materials are connected. Thus, materiality emphasises the importance of the materials or things that eventuate into an assemblage as noted in Barad’s (2007) work and, for this example, the student’s project (Ingold, 2011; Otrel-Cass & Cowie, 2019).

Tim Ingold (2011) describes the ecological properties of materials as relational. That is, the materials in context contribute to their materiality. Ingold used the metaphor of a wet rock to explain his theory suggesting that the material composition of the rock stays the same but based on environmental conditions is enacted upon by water and heat as it dries (Ingold, 2011). Materials are relational and process-based and, in this case, environmental conditions cause the rock to dry (Ingold, 2011; Otrel-Cass & Cowie, 2019). Ingold describes the materiality of things as “thingly” or the qualities of the thing which cannot be touched (Ingold, 2011, p. 9). That is, the materiality of the assemblage of steel plates led to the manufacture of a final project, not the drill or individual steel plates. Estrid Sørensen provides an alternative view of materiality in her book *Materiality of Learning* (2009). She describes materiality as being apportioned across activities and that the role of the physical and social can be allocated as material in the relational aspects of distribution. An example of social-material distribution is a student sharing her drill with other students in class. Social and heterogenous assemblages are at play. While the materials describe the innate properties of the things or artefacts used in this study, the materiality describes the role things and participants play in any given learning situation or entanglement. Given that learning entanglements are socially situated, and involve multiple designed elements with intended outcomes and, given that psychological and material tools are relational, enable materiality, and offer embodied experiences, consideration of learning dialogues that emanate from such entanglements or situations are equally important. Next, I will describe dialogism as a complementary theory.

3.6 Dialogism

Dialogues form a part of human communication and occur daily in a multitude of contexts. Crucially they represent a foundational component of human activity (Bakhtin, 2010b). Dialogues provide the means through which meaning making and ways of knowing can be formulated by participants (Ong, 1982; Wegerif, 2006). Basic dialogues are described as conversation between at least two or more participants. That is, dialogues are socially situated and are usually characterised as physical utterances (Bakhtin, 2010a; Holquist, 1981).

Dialogues may also be characterised as written forms of communication (Bakhtin, 2010a; Ong, 1982; Wegerif, 2006). The written dialogic form is traditionally monologic, meaning that written dialogic works like those in books or articles are static and provide no immediate reciprocation of thoughts and ideas between the reading audience and the author. However, reading monologic texts is a meaning-making act by the audience and provides room for individual reflection about the written dialogue (Bakhtin, 2010a, 2010b). In this case, participants are potentially engaged in the texts without spoken language or verbal utterance (Wegerif, 2007). With the advent of digital technologies communicative tools such as blogs, text messages and discussion forums, it is possible to participate in written and uttered dialogues synchronously or asynchronously. That is, certain types of technology enable the reciprocity of written dialogue, uttered or not, in both synchronous and asynchronous conditions.

The pioneer of dialogism, Russian literary philosopher Mikhail Bakhtin, described the dialogic through the voices of characters in literary texts noting the importance of multiple characters, conversations, or *voices* expressed within them (Bakhtin, 2010a; Holquist, 1981). Bakhtin extended this concept to translate into physical utterances or spoken forms of dialogue amongst human beings (Bakhtin, 2010a; Holquist, 1981; Wegerif, 2007). Dialogism proposes that dialogue may occur amongst any two or more participants, providing opportunities for understanding and knowing (Bakhtin, 2010a; Holquist, 1981; Wegerif, 2006, 2007, 2013). Participants in dialogue may consist of any combination of individuals and groups and for them dialogue is said to be relational, contextual, and historically situated (Bakhtin, 2010a; Holquist, 1981; Wegerif, 2007). Central to the dialogic philosophy are the terms *multiplicity*, *simultaneity* and *heteroglossia* (Bakhtin, 2010a; Holquist, 1981; Wegerif, 2007).

To explain this theory, Bakhtin used the example of two (or more) participants or observers engaged in discussion (Gardiner, 2002; Holquist, 1981; Oztok et al., 2014). Consider a scenario in which two people are sitting at a table talking together. Both people in the discussion are seeing, listening, thinking, and speaking. Yet each person experiences the dialogue differently as each individual occupies a different physical location and experiences his or her own unique thoughts, speech, and observations (uttered and not) at the same time (Holquist, 1981). In other words, the dialogue facilitates a multiplicity of events that occur in simultaneity (Holquist, 1981; Oztok et al., 2014). In Bakhtin's terms, the conversation is called a dialogue or dialogic event (Bakhtin, 2010a, 2010b). The multitude of languages in Bakhtin's theory are represented as heteroglossia (Bakhtin, 2010a;

Holquist, 1981). Multiple languages do not necessarily mean literal languages like French and German; rather, language represents a viewpoint or perspective of a participant in a dialogue.

In his later works, Bakhtin further defined languages into categories called *genres* (Bakhtin, 2010b). More specifically, dialogue genres employ specific terms and occur in dialogues that are unique to the genre such as words and discussions that are employed in the electrical industry or any profession or trade. For example, electricians use words such as *circuits* and *ohms* within their language genre, whereas those are words not commonly used in academia. The breadth and depth of genres and discussions are large and highly varied. Multiplicity, simultaneity, heteroglossia, and speech genres describe environmental conditions through which dialogues may occur; in other words, dialogues can be numerous (in multiplicity). They occur at the same time (simultaneity), and present through multiple modalities including thoughts, utterances, languages (perspectives), genres and voices (heteroglossia) (Bakhtin, 2010a, 2010b; Holquist, 1981; Wegerif, 2006). These environmental conditions, when viewed through the lens of the ACAD framework, provide the structure to identify the learning dialogues that transpire from within a learning entanglement or critical episode. Specifically, these conditions lead to a term I propose and describe throughout this research, *dialogic activity*, discussed in the next section.

3.7 Dialogic Activity

Learning activities and dialogues are interwoven and act mutually upon each other (Bakhtin, 2010b; Vygotsky, 1997a; Wertsch, 2007). Bakhtin (2010b) argued that "...sooner or later what is heard and actively understood will find its response in the subsequent speech or behaviour of the listener" (p. 69). It is within this domain that the dialogues and activity are viewed both in simultaneity and relationally for this research. Viewed from the perspective of the ACAD framework, an assemblage of elements in set, epistemic, and social designs enable emergent activity and learning dialogues.

This study seeks to contribute to the bodies of social-materialist and dialogic research in education by proposing the concept, dialogic activity. The word *dialogic* refers to the learning dialogues that emerge within a critical episode or learning entanglement and describes shared knowledge, shared inquiry and reflection (both uttered and not). *Activity* in dialogic activity acknowledges student agency and situated experiences with digital or physical artefacts and materials within the context of the dialogic space, the ecosystem of the learning environments. *Activity* in dialogic activity also situates dialogues in relation to actions mediated by designed elements or artefacts, where I will search for connected dependencies amongst the participants (HH, HT, TH or TT) in any given learning situation or entanglement. Thus, dialogic activity acknowledges and describes the space between the participants (HH, HT, TH or TT), the learning environment, the action, and the learning dialogues. When combined together, *dialogic activity* acknowledges the shared utterances and reflective acts alongside the doing experienced in multiplicity within the dialogic space held within the learning environments.

To summarise, Hodder's (2012) entanglement theory acknowledges the materiality of objects and their relationships with participants (H or T) that apply to a learning entanglement or learning situation (Hodder, 2012, 2014). Bakhtin's dialogism provides the foundations to identify and explain the types of learning dialogues that may emerge from within an entanglement or learning situation (Bakhtin, 2010a, 2010b). In this study, the search for a critical episode or a conjunctural event within learning situations that lead to a problem and solution helped me identify entanglements. The components of learning situations and entanglements were then abstracted through the ACAD framework structure (set, epistemic, and social designs) and the convergence of the structural elements were then examined in relation to students' co-creation and co-configuration within emergent dialogic activity. See Figure 2.

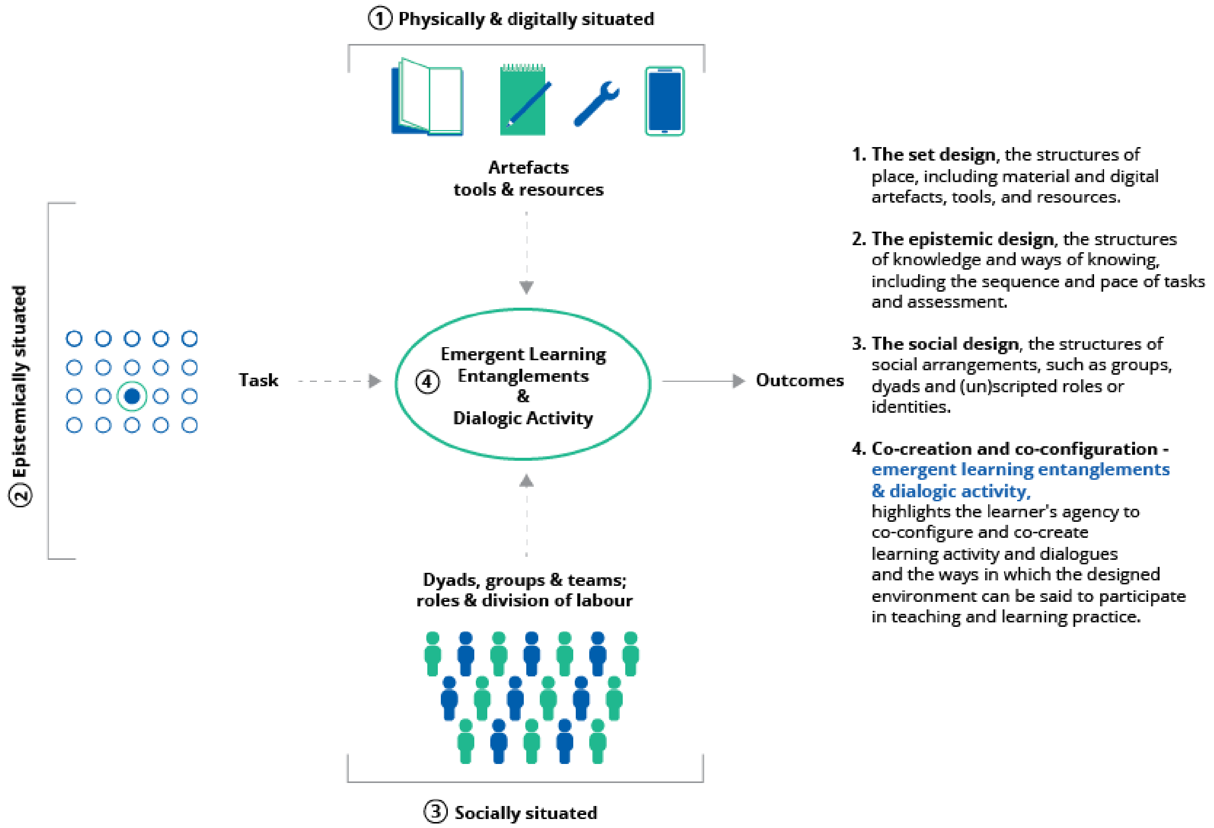


Figure 2. ACAD framework with emergent learning entanglements and dialogic activity (adapted from Goodyear & Carvalho, 2014, p. 59 and Hodder, 2012, p. 217).

3.8 Conclusion

To date, many of the social-materialist theoretical approaches focus on the relational aspects of the things or artefacts, the social or human aspects, or the physical or digital spaces in a learning entanglement. This research explores learning and dialogic entanglements by employing the theoretical lenses of the entanglement theory and dialogism, arguing that dialogues and entanglements between humans and things, within a BL environment, are enmeshed. I propose the term dialogic activity, which suggests that learning dialogues and entanglements can be explored relationally, based upon their dependencies. It is within this space, between the activity and utterances that I situate the theoretical foundations for this research.

By leveraging an interdisciplinary theoretical lens, I consider the dialogic in any given learning entanglement. The dialogic provides opportunities for learning entanglements. Conversely, learning entanglements provide opportunities for the dialogic, both relationally and in simultaneity. Both the dialogues and the materials are enmeshed within activity; one is no more important than the other and each entanglement is heterogenous. The theories are applied to the structure of the ACAD framework to identify the participants and setting and for the learning entanglement.

Next, in the following chapter, I outline the methodology for this thesis.

4 Methodology

4.1 Introduction

Crotty (1998) identifies four key components of any research undertaking: epistemology, theoretical perspective, methodology and methods. The epistemology, theoretical perspective and methodology will be outlined in the following sections and the methods will be discussed through the research design, data collection, and data analysis sections of this chapter. Grounded in the epistemological and theoretical perspectives chosen, the research design, the mediating effects of course design and artefacts, the emergent learning dialogues, and students' and teachers' perspectives of them, as well as their learning entanglements, are made visible.

4.1.1 Interpretivist epistemology

Epistemology refers to the "theory of knowledge embedded in the theoretical perspective and thereby in the methodology" (Crotty, 1998, p. 3). This research aligns with the interpretivist epistemology in that "a single phenomenon may have multiple interpretations" (Pham, 2018, p. 3). That is, the individual and society are viewed as inseparable and, thus, social action is inherently meaningful (Crotty, 1998; Flick, 1998). The interpretivist researcher attempts to understand perspectives of reality from the participants' viewpoint and acknowledges that many interpretations and perspectives may be present (Pham, 2018). That is, knowledge is personal, subjective and based on the unique experiences of the participants in fluid social contexts (Hammersley, 2018; Pham, 2018).

For this research, it is important to connect interpretivist understandings into the research context of BL trades training environments. Individuals experience different realities based on their prior knowledge, previous experiences, attitudes, skill sets, as well as their previous experiences in former learning settings with students and teachers. It is the students' active learning or how they construct their knowledge that interests the interpretivist researcher. Observation of why students do things, how they do things, and why, in various contexts, are key to interpretivist research (Pham, 2018). The choice of an interpretivist lens enables me, as a researcher, to understand the complexities of how the designed aspects of learning in a trades environment, how students work together, and the artefacts used, impact and mediate students' conversations and learning activities.

4.1.2 Basic qualitative/interpretivist methodology

The methodology connects to the epistemology and theoretical perspective employed and is the "strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Crotty, 1998, p. 3). Since the educational context for this research is complex, the methodology was carefully considered. The qualitative/interpretive methodological approach allowed me to understand how events, processes, and activities were perceived by participants. In this research, it was essential that social practices relating to dialogic activity were shared and, to that end, the participants' experiences, knowledge, views, perceptions and reflections are crucial (Patton, 2015).

This research approach enabled me, as the researcher, to:

- Develop an understanding of how tertiary trades environments impact students' dialogues.
- Explain how BL environments, students' conversations, interactions, designed tasks and artefacts impact emergent dialogic activity.
- Capture stories of how students engage in these environments and their perspectives.
- Draw out themes within each case and then compare the findings of each case to discover any overall patterns or themes.

4.2 Research Design

Research design formulates the basic structure and design of a research project and supports the direction and systematic preparation for the design (Flick, 1998). The following section describes the nature of this study.

4.2.1 Participant ethnography

Ethnographic research is qualitative research that focuses on what Reeves, Kuper, and Hodges (2008) explain as "…the study of social interactions, behaviours, and perceptions that occur within groups, teams, organisations, and communities" (p. 512). The researcher acts as an observer and participant and situates him or herself amongst the study's participants over extended periods of time (DeWalt & DeWalt, 2011; Roberts, 2009). Participant observation enables the researcher to gain insights into a context and collect data about the participants whilst engaging with them (DeWalt & DeWalt, 2011). These observations provide opportunities to gain further insight into the participants' interactions, dialogues, and behaviours (Gans, 1999; LeCompte & Schensul, 1999). As a research method, participant observation provides a complementary context for other modes of data collection (DeWalt & DeWalt, 2011; LeCompte & Schensul, 1999).

As a participant ethnographer, I assumed the role of a *friendly-incompetent*, mainly asking open-ended and exploratory questions for clarity so that students could provide explanations in detail to me (DeWalt & DeWalt, 2011; Jorgensen, 1989). These occasions provided opportunities to collect in-the-moment qualitative information which could yield insight into how the students perceived their participation against how I observed it (J. J. Schensul & LeCompte, 2012; S. L. Schensul, Schensul, & LeCompte, 1999). In addition, I was able to respond to questions and concerns students had regarding the study. While it was impossible to record in my fieldnotes all dialogic moments and activity as a participant ethnographer, it was possible to witness and identify significant dialogic learning moments, or what I called vignettes, for case analysis.

4.2.2 Multiple case study

Research design formulates the basic structure of a research project and supports the direction and systematic preparation for the design (Flick, 1998). The design of this study is ethnographic and followed a multiple-case study approach involving three Level 3 trades courses at Unitec, namely, Automotive Engineering, Electrical Engineering, and Mechanical Engineering. The case study approach involved multiple embedded units of analysis related to teaching spaces used, to people, and to artefacts (Yin, 2014). The strength of this approach was that it combined a variety of information sources to obtain data about each case which, in turn, enabled the triangulation of data from multiple sources (Yin, 2014). The units of analysis for each case included artefacts from face-to-face and online spaces, videotaped classroom sessions, written weekly student questionnaires, and interviews with instructors and students. Between 15 and 30 students were enrolled in each of the three courses. Five students participated from Automotive Engineering, five students participated from Electrical Engineering and four from Mechanical Engineering and were all directly involved in the research. The data-collection period covered a total of 126 hours, in single 3-hour sessions per week with each cohort during a 14-week semester. This research design was selected as it was expected to yield a rich bank of data that would address the research questions (Smith, 1978).

The research design included three embedded (multiple) cases. The multiple embedded case design allowed for multiple units of analysis, to interrelate findings to explain the dialogic activity, artefacts, settings and students' perceptions under investigation for each case (Scholz & Tietje, 2002; Yin, 2014). Once the cases were investigated separately, their findings were compared and analysed for findings integration based on the research questions (Scholz & Tietje, 2002; Yin, 2014). See Figure 3.

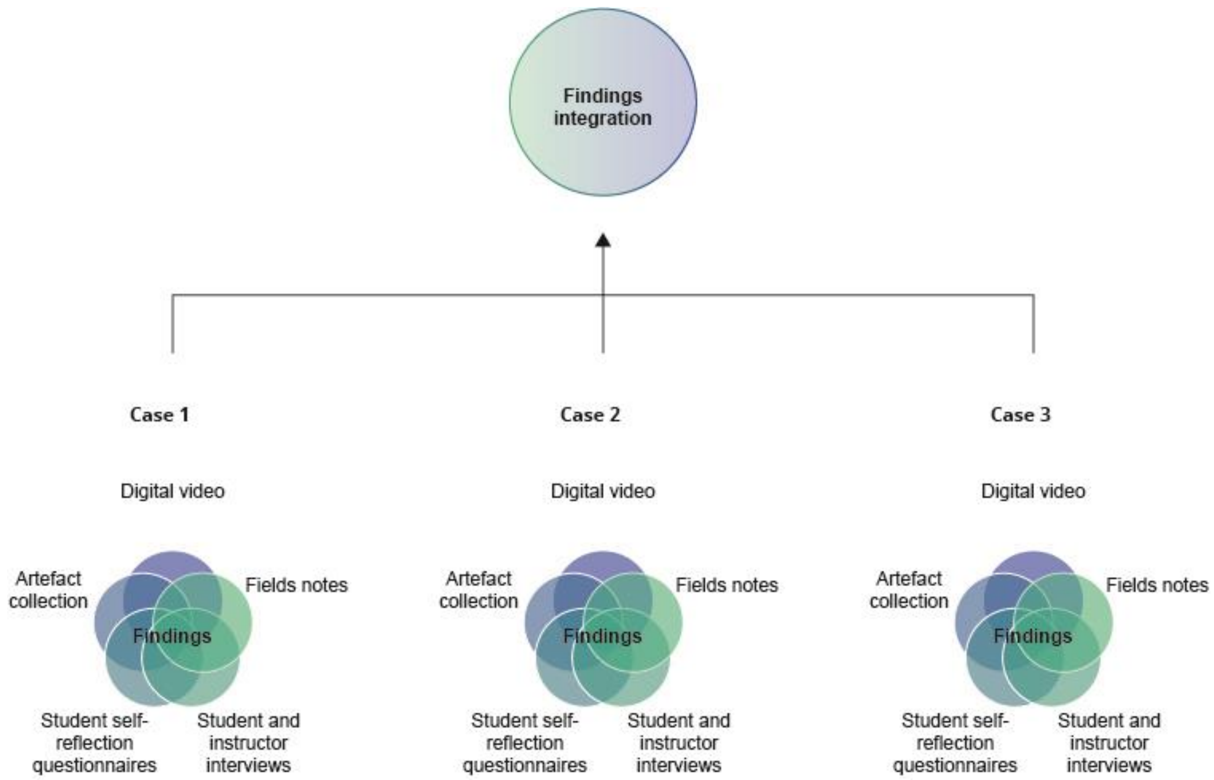


Figure 3. Multiple embedded case study. Modified from Yin (2014, p. 50).

A challenge with multiple embedded units of analysis includes the failure "to return to the larger unit of analysis," or the original research questions (Yin, 2014, p. 55). It was important to remain focused on the research questions as they applied to the integration of the findings or the "target" of the research. That is, it was important to avoid getting lost at the sub-unit or case level of analysis which provided the overall "context" of the research (Yin, 2014, p. 56). The selection of the multiple cases was important to consider as I observed the same phenomenon – dialogic activity – across the cases; this is also known as replication logic (Yin, 2014, p. 57). Owing to the replication logic, multiple case studies are regarded as being more robust than a single case study and added strength to this research design (Yin, 2012, 2014).

The units of analysis for each case in this research included different modalities of data collection (see Figure 4). These provided opportunities for triangulation of data which enhanced the strength of the study since they were able to provide multiple ways to verify themes or activities of interest in the study (Yin, 2014). Digital video recordings captured participants' learning dialogues and their associated activities as well as the learning environments they used including digital technologies, such as a smart phone or LMS software. Field notes were taken each session and re-written after the observed session in a digital format. In addition, learning situations or critical episodes were identified during each observed session and noted in the field notes. Self-reflection questionnaires were filled out by the study participants at the end of each session and semi-structured interviews were conducted mid-semester with all participants. See Appendix S for the cohort, LMS, and software required for students' to use in their respective courses. See Appendix R for a table of the observed artefacts used in the face-to-face sessions.

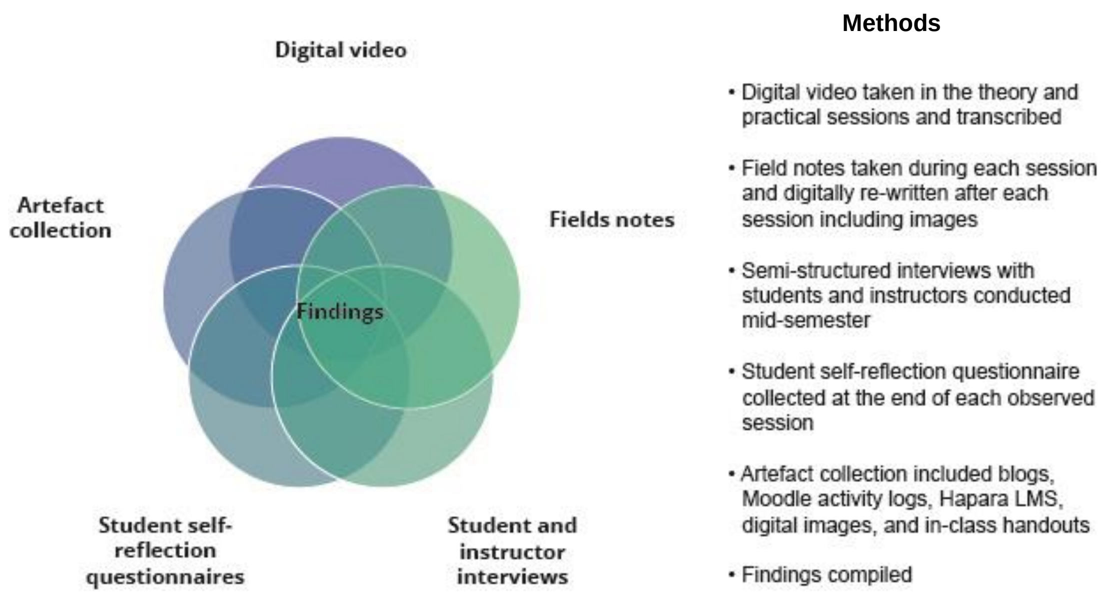


Figure 4. Units of analysis for each case including methods.

4.2.3 The setting

Unitec was selected as the site for the research. At the time of data collection, Unitec was New Zealand's largest polytechnic institute. Situated in Mt. Albert, Auckland (a central area with easy access), Unitec serves communities from the south, west, and north of Auckland and, at the time of this research, accommodated approximately 8,000 full-time students. Trades training programmes constituted a large portion of the programmes offered. The Level 3 certificate trades training courses offered many students opportunities to gain entry-level apprenticeships into their trade of choice or the opportunity to continue to Level 4-degree programmes.

4.2.4 Site selection

Officially opened in August of 2017, Te Mataaho, or Unitec's trades training building, is the largest open trades training building in New Zealand consisting of 7000m^2 (Unitec, 2017). It houses virtual and emulation equipment as well as machinery and tools with which students gained hands-on experiences through their courses and in preparation for the work environment (Unitec, 2017). The building was designed with multiple learning spaces for multi-purpose trades teaching and learning. The courses were conducted in large shared spaces emulating real-life worksites while simultaneously exposing students to other trade disciplines (Unitec, 2017). The Level 3 technical trades courses, Automotive Engineering, Electrical Engineering, and Mechanical Engineering were conducted in separate, open, physical spaces within Mataaho depending upon what was scheduled to be taught on the day. These spaces included, but were not limited to, the chassis, engines and electronics area, engine dismantle and reassembly area, break-out rooms, the electrical wiring area, the welding bay, and the Automotive Engineering lab (Level 2) which contained simulation and diagnostic equipment and virtual welding simulation equipment. See Figures 5 and 6.

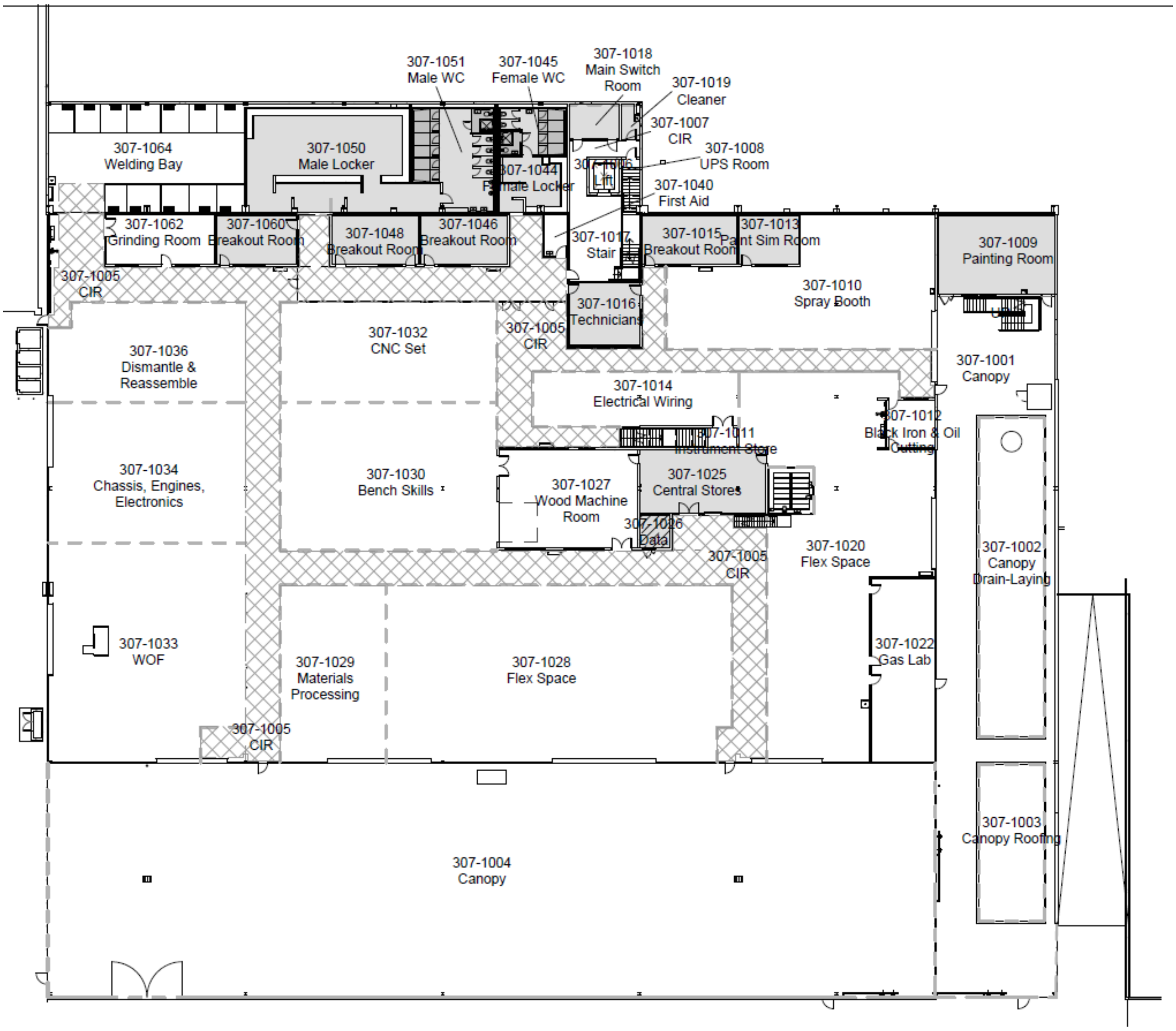


Figure 5. Mataaho B304 – Level 1 floor plan (Dimyadi, 2014a).

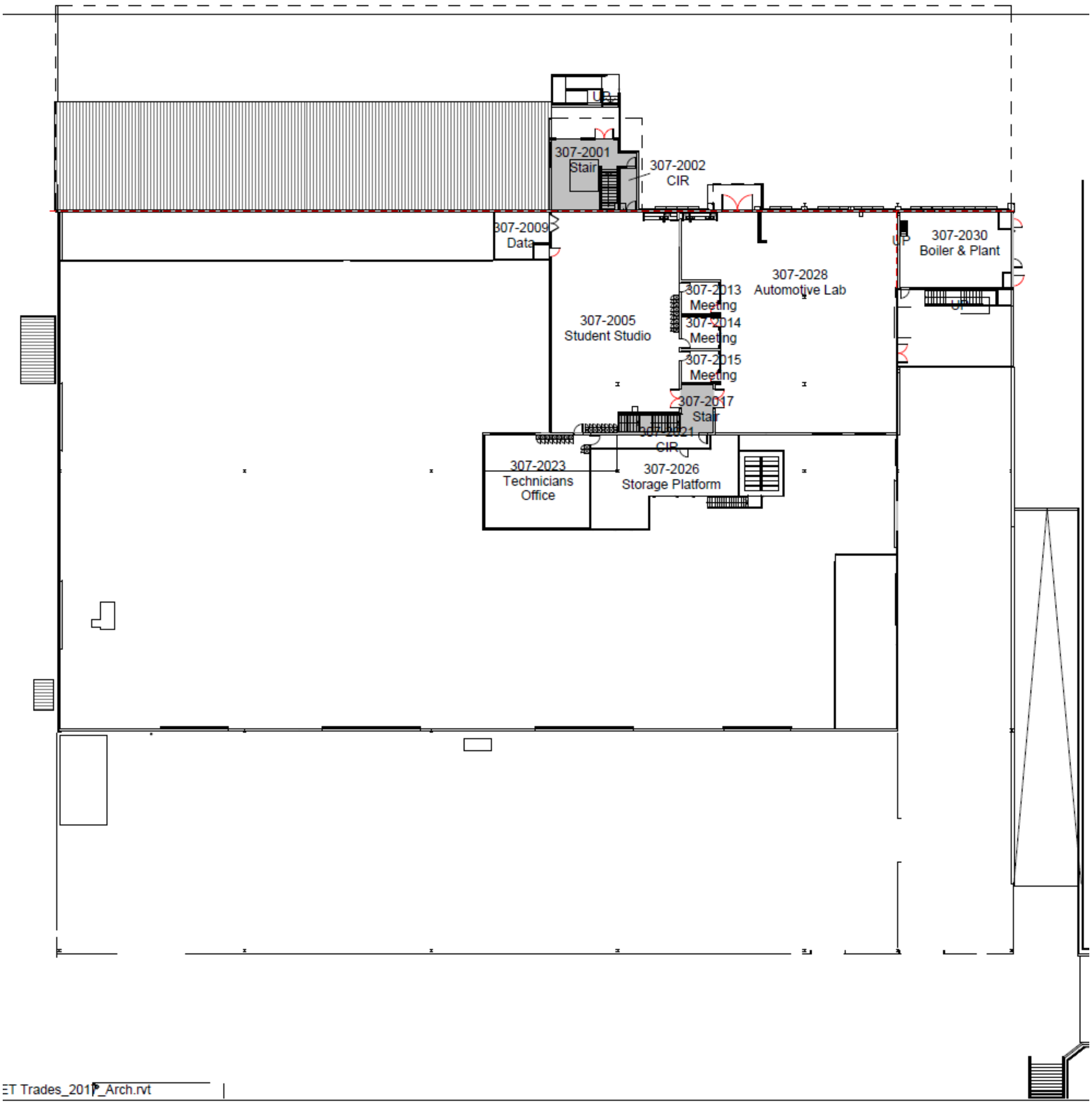


Figure 6. Mataaho B304 - Level 2 floor plan (Dimyadi, 2014b).

Since Mataaho was new at the time of this research and provided some modular and configurable spaces for trades teaching and learning, it was selected as the main location to observe the practical sessions. Each course observed for this study included a lecture or theory component and a practical component for students to conduct their activity and practise their skills. The lecture components were held in the breakout rooms in Mataaho or within other buildings on campus. Whilst much of the equipment could not be moved or reconfigured for student activity, some of the breakout rooms and work areas allowed students to reconfigure them, providing flexibility, similar to flexible learning spaces (Benade, 2017, 2019; Ministry of Education, 2016). These spaces can be configurable to change based on what the student prefers or requires (Ministry of Education, 2016). A flexible learning environment refers to a large physical space that is configurable which usually contains learning artefacts such as moveable whiteboards, tables, chairs or other moveable furniture or aids that enable learning and allows for the teaching of multiple cohorts at the same time (Benade, 2019; Ministry of Education, 2016). The significance of choosing Mataaho is that it is one of the first trades environments in New Zealand to provide open, flexible spaces for trades learning – an uncommon feature for many trades training environments.

4.2.5 Sample selection

Since 2014, pre-apprentice Level 1-3 courses at the tertiary education level have been deemed high priority due to an increase in demand for those skills as anticipated by the New Zealand government (Ministry of Education, 2020a; New Zealand Immigration, 2020). The Level 3 certificate courses selected for this study included Automotive Engineering, Electrical Engineering, and Mechanical Engineering courses. Each Level 3 certificate provided students with the skills and knowledge required for apprenticeships or entry level positions in their respective trades (NZQA, 2018). Table 1 lists the certificates and the career path that students are able to obtain upon course completion.

Table 1

Level 3 Certificate Course and Career Options

Level 3 Course	***Career Options***
National Certificate in Automotive Engineering	Trainee or apprentice mechanic (Unitec, 2018a)
National Certificate in Electrical Engineering	Apprentice electrician (Unitec, 2018b)
National Certificate in Mechanical Engineering	Apprentice welder, fabricator or an apprentice mechanical engineer (Unitec, 2018c)

A total of 14 students volunteered to participate in this research. I did not expect to receive more than four acceptances from each cohort to participate. When a fifth student from the Electrical Engineering cohort and from the Automotive Engineering cohort provided written consent to join the study, I considered it unfair to the students not to include them. The additional students from Automotive and Electrical Engineering participated in the theory and face-to-face sessions including the weekly questionnaires but did not participate in the student interviews. A total of 12 students participated in the student interviews.

4.3 Data Collection

4.3.1 Health and safety and PPE

Since I was observing students in Mataaho, I was obliged to comply with Health and Safety regulations which included personal protective equipment (PPE) as required by New Zealand Law (Worksafe NZ - Mahi Haumaru Aeotearoa, 2021) to enter areas in which students worked on hazardous machinery and equipment. Health and safety practice briefs were conducted by the instructor at the beginning of each practical session and the protocols sometimes differed based on the tasks for the day. These included wearing steel-capped boots, eye protection, a hair tie, and a 100% cotton dust coat to participate in these classes and sometimes involved changing this attire as the relevant activity necessitated (See Figures 7 to 10). For example, as I observed the welding tutorials, I wore a welding helmet to protect my eyes and skin from UV radiation emitted by the welding torch.

Figure 7. Researcher wearing welding helmet.

Figure 8. LED Controlled welding helmet.

Figure 9. High visibility vest on tripod.

Figure 10. Researcher in full PPE.

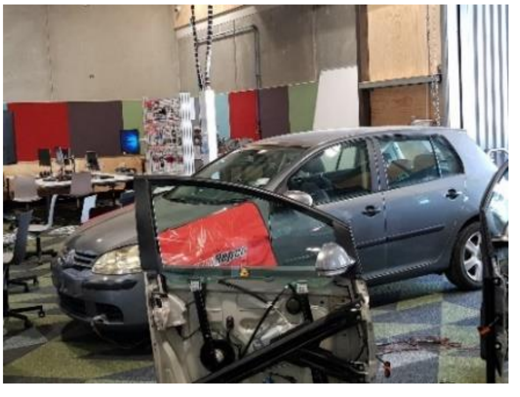
In addition, sometimes I covered the legs of the video camera tripod with a high visibility vest so students could see the tripod and not trip over it**.**

4.3.2 Physical learning spaces

The physical learning spaces utilised for the students' practical sessions varied and were dependent upon the course schedule and designed learning tasks. The following, Table 2, provides a few examples of key teaching spaces including their relevance and purpose. It is important to note that the breakout spaces, in which theory classes took place, did not require the use of PPE, as discussed in section 4.3.1.

Table 2

Observed Teaching and Learning Spaces Including Potential Hazards

Course	Space Name & Location	Purpose/Hazards
Automotive Engineering	Automotive Emulation Lab Level 2 	Simulation Equipment • Identify potential daily hazards • Electronics in the back of the room • Workstations for students to use to access information and the LMS • Automobile to practise on
Electrical Engineering	Electrical Wiring – Level 1 – Workbench 	Electrical Machines 3 phase workstation equipment • Electrical testing and monitoring equipment • Space to wire electrical board to different configurations using schematics • Each workbench included 3 to 4 workstations in a row for students to conduct their work

Course	Space Name & Location	Purpose/Hazards
		• Each workbench included a kill switch to immediately cut off the power in case of an emergency
Mechanical Engineering	CNC Set Area – Level 1 – Component assembly 	Manufacturing and assembly area for componentry • Identify potential daily hazards • Steel benches for assembly of items and for students to work on • Trailer Mover pictured in foreground

Course	Space Name & Location	Purpose/Hazards
Automotive Engineering and Mechanical Engineering	Welding bay – Level 1 – Welding workstation 	Welding bay • An area for students to practise welding • A series of 10 welding bays • Infrared curtains surrounding the welding bays to protect people (not wearing welding helmets) from UV radiation
Automotive Engineering and Mechanical Engineering – breakout room in Mataaho	Breakout Rooms – Level 1 	Lecture breakout room • Lectures and theories discussed • Students sat in either horseshoe configuration or in rows with the lecturer facing the front using the whiteboard and the monitor connected to their laptop if required • The chairs and tables were on wheels and could be moved to suit the theory or group work required for the day

4.3.3 Student observations

Student observations were conducted weekly in 3-hour, face-to-face sessions comprising a combination of theory and practical sessions depending on progression of curriculum set for each cohort. For example, for the Mechanical Engineering students, numerous welding theory and safety sessions were conducted before students were permitted into the welding bays to use the equipment. Digital video data were recorded weekly for each session for each cohort. Student participants were anonymised by assigning a number, e.g., Student 1, Student 2, etc. and similarly instructors were assigned a number, such as Instructor 1.

I carried my video camera on a tripod and recorded students as the sessions progressed. I observed students and when appropriate I would ask questions to understand their activity. I also simultaneously recorded field notes in my journal (see Section 4.3.4). A benefit to in-person student observation over an extended period was that as students became more familiar with me; they were more willing to engage. Another advantage included that I was able to shadow my participants in different locations within the space whilst simultaneously having an overview of the activity within the greater space in which the whole class activity was conducted. (This area was much larger than the field of view in the video camera). In addition, being on site enabled me to capture students' reflections immediately after their sessions whilst details remained fresh in their memories. It was intended that the students would complete their reflection questionnaires online. However, most students expressed a preference to complete the same questionnaire using a paper-based format. To accommodate their preferences, I printed off the questionnaire for them to complete. After collection of the responses, I recorded them into an Excel worksheet.

A potential draw-back to observing the students in class was that they may have experienced the Hawthorne effect; that is, they may have changed their behaviour due to my presence, knowing they were being observed (Landsberger, 1958). Another challenge of being a participant observer was that I found it difficult to record all my observations in my notebook during and after each interaction with students because the environments were so fluid. However, an advantage of using video recordings was that I could return to any moment of interest for further analysis. An additional advantage to the use of the video camera in this study was that I could take photos at the same time I recorded the students.

After the semester finished, I reviewed my field notes and recorded sessions to identify critical episodes that could illustrate an aspect of a learning situation or entanglement for further analysis. A critical episode was selected to be composed within a vignette when a student self-reflection questionnaire was cross-referenced with it, showing the student experienced a reflection about the critical episode. Because self-reflection forms an integral part of shared dialogues (including knowledge and inquiry), students' self-reflections were required for the composition of the vignettes based on Bakhtin's (2010b) explanation that they occur in simultaneity. Once selected, a critical episode was written up as a vignette using notes, video recordings, self-reflections and observations. I noted the lecture, video time stamp, cohort, and any other relevant information in a customised multimodal table using MS Excel (Hennessy, 2020). A multimodal table or spreadsheet is one in which the learning events, or critical episodes, were recorded against a timeline, with each row representing an increment of time (Hennessy, 2020). However, for the purposes of this study, I organised the worksheets by a critical episode identified each observed week in the field notes. That is, instead of mapping a critical episode by time periods such as minutes or hours, activity and words, they were identified alongside other elements, such as learning events, people, and materials involved in them. The columns in the spreadsheet were organised in the following way: date, description, BL mix, spaces social configuration, evidence of dialogic activity, artefacts used, if the critical episode was chosen for a vignette analysis, LMS activity log information, weekly reflections, identify if types of dialogic activity were present, and entanglement properties. Tables 3 and 4 present an example multimodal table (split in half) showing the selected critical episodes for the Mechanical Engineering case.

Table 3

Custom Multimodal Mapping Table with Critical Episodes – Mechanical Engineering, 1st Half

Week	Date	Description	Blended Learning Mix	Spaces	Social Configuration	Evidence of types of dialogic Activity (conversational Snippets)	Artefacts used to impact dialogic activity (digital and physical)
Week 5	22/08/2018	Welding tabs and working with jigs	Planning their welding projects	Welding bays	Instructor demonstration and individualised student work - although many worked in pairs to take turns on the machines	Not much unless I specifically asked questions after – due to health and safety considerations	welding equipment, PPE, jigs pens and paper
Week 6	29/08/2018	Planning the trailer mover	Bookwork on their computers with work in Fusion 360	337-1048 - breakout room	Groups created by the instructor for the trailer mover project	Discussion about Fusion 360 drawings – for planning their final project	Pen paper desks, computers, Fusion 360 and LMS Hapara
Week 14	14/11/2018	Discussions about the final projects	Final project on the Hapara LMS and completing their work, their welded pieces for assembly	337-1048 - breakout room	Self-selected and project groupings or alone	Analysing challenges with their projects and solving them.	8 42 - these slots are too far apart

Table 4

Custom Multimodal Mapping Table with Critical Episodes – Mechanical Engineering, 2nd Half

Week	Critical Episode	Vignette chosen for transcription and analysis	LMS Log student activity (Look at logs spreadsheet)	Weekly Reflections (Look at reflections worksheet)	Check with Field Notes	Types of dialogic activity	How do material and digital artefacts impact dialogic activities?
Week 5	MAH00262 - 00:14 - 22 8 18 – Instructor and students figuring out how to weld the tabs on the jig	**X** **On planning**	**LMS logs only show if student has been in the site doesn't specify the nature of activity	Student 12 – stated it was his first day of school week so nothing to say yet on how he could do better, he's only been grinding down tabs, Student 11, said that he learned correct ways to hold work in place while he welds, jig to hold down work, and he needs to check his measurements as he's always a few mils off	**X**	Cumulative,– exploration of schematics	**X** **TH, HT**

Week	Critical Episode	Vignette chosen for transcription and analysis	LMS Log student activity (Look at logs spreadsheet)	Weekly Reflections (Look at reflections worksheet)	Check with Field Notes	Types of dialogic activity	How do material and digital artefacts impact dialogic activities?
Week 6	MAH00340 - Students discussing their Fusion 360 drawings - 1:35 mark	**X** **On disruptive support technology**	**LMS logs only show if student has been in the site doesn't specify the nature of activity	Student 12 – wants to share more and talk with the group he also wants to open up more with the group, Student 11 – realized his fusion skills are very lacking and needs to work more	**X**	Inquiry and shared knowledge, Interruptive Wi-Fi - stopping work	**X** **TH, HT**
Week 14	MAH00910 – distances between the slots are in incorrect position – discuss a solution – 3 59 mark	**X** **On problem solving**	**LMS logs only show if student has been in the site doesn't specify the nature of activity	Student 11– I need to look at the bigger picture sometimes I miss some important things I should have done on the trailer mover Student 10 states – that he's fine where he's at	**X**	Cumulative	**X** **TH, HT, TT, HH**

Next, I transcribed what was said in the critical episode and provided an analysis and description of the context as the vignette. I found at least three significant critical episodes that correlated in some way with a student's reflection for each cohort. I transcribed the dialogue for each critical episode using the edited transcription method (Davidson, 2009). This method allowed me to remove unnecessary words such as "ums" and "ahs" from the transcripts. A potential drawback to this method is that important information may be left out. However, by extracting the video vignettes myself, I was able to establish specific standards over editing decisions of what was spoken, to dig into the data by re-hearing what was said, to re-witness the activity, and to think about the data as I was typing. The process required frequent rewinding of the digital video to capture words that may not have been clear and although time intensive, proved to be a valuable process for me as a researcher.

4.3.4 Field notes

Field notes were taken and images of the artefacts that were created during the face-to-face sessions were collected, such as writings on the white board, or handouts or activity sheets. I used a template (Appendix P) to prompt me to record relevant information I observed during the face-to-face sessions at the same time the video camera was capturing student activity. The field notes included details about each session including: the class or cohort, date and time, topic of the day, who was present, who participated with whom, artefacts used, and spaces used.

Drilling down further, I took notes about the environment, what students wore, student behaviours, student pairings or group configuration, and what occurred between the students and the instructors. In this process I was especially interested in identifying ways participants shared knowledge, shared inquiry, and I reflected based on student activity. I noted significant activities of interest, critical episodes, during each observed session in the field notes. I also recorded environmental conditions such as odours, temperature, noise, electrical dangers, and more. Once the session was finished, on the same day I transcribed my hand-written notes and interpretations into fully written observations for each session in a password protected Google Drive account created for this research (see an example in Figure 11). These written observations recorded notes, images, and links to concepts that were new to me and important to understand for conceptual and contextual reasons. I maintained a separate, colour-coded notebook while in the field for each cohort of students: black for the Automotive Engineering notebook, yellow for the Electrical Engineering notebook, and blue for the Mechanical Engineering notebook.

Monday the 27th of August

- Mataaho - Originally scheduled for under the canopy but [redacted] organized with two other cohorts to work in an alternative area because we had to use the engines on blocks to be able to test electronic fuel Injection
- Student configurations were: [redacted]
- Class started at 8:30 AM but most students arrived a bit later
- We discussed safety and students had to put on PPE
- Next students were tasked with reading the booklets and checking the engines
- The first practical session which went until 10AM - was the Testing Electronic Fuel Injection Session
- Students had to use a multimeter to test the voltage on the engine - and there were a multitude of ways to test it.
- Students had to hook up the motors to exhaust extractor hoses so it went outside - students tested the motors
- Had to move the engines which impacted the teaching time

Figure 11. Digital field notes showing a diesel engine on wheels.

4.3.5 Artefact collection

Artefacts for the purposes of this research included any tools, physical and digital, that provided opportunities for dialogic interaction. Data collected related to both “design artefacts” such as handouts prepared by the teachers and artefacts produced by participants during their "activity," for example, blog comments or team project presentations.

4.3.5.1 Students

Artefacts collected included course logs, physical and digital tools used, both online and offline, including trades specific physical tools and artefacts, workbooks, handouts and content provided by the LMSs including Moodle and Hapara, a third-party application that works in conjunction with Google Classroom (see Appendices R and S). The data were collected through digital pictures and video, screen shots, and on-line activity log backup files. The collection of artefacts was securely stored digitally in a database. Paper based artefacts were stored in a locked folder file on site at the Massey University's Albany campus. Since a wide variety of data was collected from multiple sources for only a small number of participants, the volume of data collected was manageable. It is important to note that the data provided by the LMS course logs indicated mainly time and frequency of access to the LMS's used, if students downloaded content, and specific "on click" activity. "On click" activity meant that a student clicked on an item displayed on the LMS web page. This dataset was problematic because it simply meant that students clicked on an item, and it did not indicate the way a student engaged with a content item or how they used it or if or how they shared the content item with others. The LMS log information was collected but not used in the data analysis for this research.

4.3.5.2 Instructors

Artefacts collected from the instructors included digital and physical documents and information collected from the learning management system. The learning management systems used provided information on how the instructors designed the course as they included the course schedule, assignments, and rubrics as well as the support resources for students' learning (Appendix S).

4.3.5.3 Weekly student participant self-reflective questionnaires

At the end of each session, students were asked to fill out either a paper-based or electronic questionnaire (Appendix Q). The purpose of this questionnaire was to gather students' reflections about their learning experiences for the week. The questionnaire responses were stored in digital photos for the paper-based questionnaire or electronically through a Google form. (See Appendix R for the full list of observed artefacts.)

Whilst the students using the paper-based questionnaires captured the responses immediately at the end of each session, the digital questionnaire responses did not always arrive until days later, potentially impacting students' recall of the session queried. However, only one student participant chose to use online questionnaires. The main benefit of offering dual modality questionnaires is that they facilitated students' preferences. Although this required additional administrative work to coalesce the responses into a spreadsheet for review, the work was manageable due to the small sample sizes.

Other challenges included the potential for dishonest answers, unanswered questions, and rushed responses. Sometimes it was observed that the participants were in a rush to leave the session. Another concern was the potential for differences in understanding of the questions and differences in interpreting them, contrary to what was intended. I tried to get a full picture of what the students thought about the session by comparing the questionnaire responses to the evidence shown in the videotaped sessions and written in my field notes.

4.3.6 Semi-structured interviews

In weeks 10–11, the students and instructors participated in semi-structured interviews. A total of 12 students were interviewed, with one student from Electrical Engineering and the other from Automotive Engineering opting not to participate. For these interviews, appropriate information sheets were provided, and consents were sought (Appendices J, K, M, and N). The interviews elicited information about the activity students participated in in the weeks leading up to the end of the semester (see Appendices L and O for example interview guides). The student interviews focussed on their preferred activities in the face-to-face and digital environments and included the digital and physical tools they used for their learning, shared knowledge, shared inquiry, their preferences for specific learning spaces both digital and physical, and any interesting events or activities in the class that were previously noted. The instructor interviews explored course designs and learning tasks and the provision for students to share knowledge, inquiry, and reflection. The instructors were asked about the ways in which they felt their courses were successful and what they felt needed improvement.

The semi-structured interview format was chosen to explore the research questions in more detail with the study's participants. The semi-structured interview allowed specific interview questions to be asked within a sufficiently loose structure to allow for the exploration of spontaneous issues or points raised during the interview (Ryan, Coughlan, & Cronin, 2009). Questions centred around the research themes as well as other ideas or themes of interest that arose during the interviews. The semi-structured interview provided more opportunities for insights into the participants' activity and understanding than what would be possible from a prescriptive approach, such as a standardised interview (Huang, Kinshuk, & Spector, 2013). A limitation with the semi-structured interviews was that the results of each interview varied since the participants came from different backgrounds, perspectives and experiences (Ryan et al., 2009).

4.4 Data Analysis

This section describes and justifies the methods and tools used for the analysis of data for this research. As stated previously, I noted significant activities of interest, or at least one critical episode, during each observed session, such as learning entanglements or situations, which could form the basis for potential vignettes during each session to refer to. I entered each of these into a customized multimodal table for each cohort described in section 4.3.3 (Tables 3 and 4). Within each table I included the following information or details about its context: date, description of the critical episode, BL mix, spaces used, social configuration, evidence of types of dialogic activity, artefacts used, video information, if the critical episode was selected for vignette write up, LMS log activity, weekly self-reflections, cross-referenced with field notes, types of dialogic activity, and entanglement configuration (HH, HT, TH, or TT). The table enabled me to consider the heterogenous mix of humans, activity, artefacts and dialogues, both shared and reflections, within each critical episode and their associated themes.

Thematic analysis allowed the identification and analysis of patterns to emerge across the data sets in this qualitative research (Clarke & Braun, 2013). There are six specific phases in conducting thematic analysis and they include: familiarisation with the data, coding searching for themes, reviewing the themes, defining themes, naming themes and writing them up (Braun & Clarke, 2006; Guest, MacQueen, & Namey, 2012). Familiarisation with the data was obtained by reading and re-reading it or in the case of digital video, viewing and re-viewing it. Once I started this iterative process, I assigned labels or codes to themes in the text (see Figure 12). After I coded the relevant data to each theme, I began refining and reviewing the themes within each vignette for each case, checking for consistencies and differences using Nvivo and MS Word.

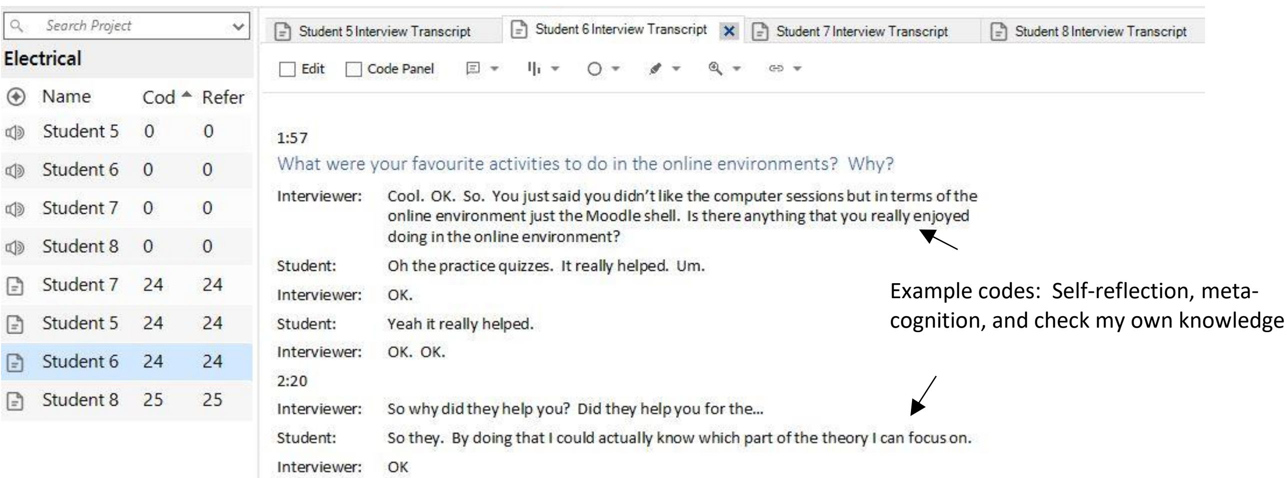


Figure 12. Nvivo student interview example with codes.

Next, I completed the themes analysis by writing it up by "…weaving analytic narrative and data extracts…" to tell the story of the data within the vignettes (Clarke & Braun, 2013, p. 3). I composed the vignettes including the critical episodes and the cross-reference self-reflection questionnaires. A vignette for this research included an interpretive narrative of the learning event with instructor responses about course design with student insights based on their interview data, student reflections, and observations. I began with a consideration of the designed elements for each case from the instructor interviews. By drawing upon the ACAD framework, I was able to identify the core elements of a course design, and to then consider how these elements influenced student activity (Carvalho & Goodyear, 2014; Goodyear et al., 2021). As explained in the theoretical review chapter, the framework is organised into four specific dimensions: "set design," "epistemic design," "social design" and "co-creation and co-configuration activity" (Carvalho & Goodyear, 2014; Carvalho & Yeoman, 2018; Goodyear et al., 2021).

Importantly, a vignette was chosen for analysis only if the student's self-reflection complemented the data from the critical episode. This resulted in three vignettes per case for a total of nine vignettes across the study. Once each vignette was complete, the student and teacher interviews were transcribed and uploaded into Nvivo (see Figure 12), a qualitative analysis software package. The interviews were then compared with the findings in each of the vignettes.

The following table outlines the order in which I analysed each case:

Table 5

Case Analysis Steps

Task	Action
1. Data collection	Video, photo and physical artefact collection
2. Select one critical episode of interest each week	Recorded in field notes
3. Create a custom multimodal spreadsheet	Recorded all relevant information about identified critical episode into spreadsheet (see Tables 3 & 4)
4. Identify the three relevant critical episodes for vignettes in each case	Watched video and read field notes; noted this into spreadsheet
5. Vignette creation	Composed vignettes including critical episodes, and framed them with ACAD framework, student insights based on interview, and observed data
6. Transcribe the student interviews and upload them into Nvivo	Triangulated themes from interviews with themes in vignettes for student perspectives. Student interviews were uploaded into Nvivo and thematic analysis conducted
7. Transcribe instructor interviews and upload them into Nvivo	Compared instructor interview findings with vignettes and student perspectives' findings
8. Analysis & write up	Authored each case with three vignettes including analyses and findings

The next section discusses the challenges, limitations, reliability and transferability of this study's methodology.

4.5 Challenges, Limitations, Transferability and Reliability

Throughout the duration of the data-collection period, I encountered many opportunities and challenges. Sometimes this involved observing either theory or practical sessions on my allocated data-collection day and sometimes this involved the observation of both. Whilst the small student sample sizes for each case do not allow for generalisability, the prolonged engagement with the students, complemented by interviews, artefact collection, and video recorded sessions, provided rich opportunities for in-depth observation and exploration of the data (Onwuegbuzie & Collins, 2007; Yin, 2014). That is, the learnings from this research offer potential transferability—the learnings may potentially be applied to other research contexts for further study.

An additional challenge was that the time-intensive nature of the project over a semester might create conditions of familiarity—a potential risk for the data collection (J. J. Schensul & LeCompte, 2012). That is, as a participant observer, students might become too familiar with me as a person, and they might change their in-class behaviour because of this. Further, as the study progressed toward the end of the second semester, students were preparing for their final assessments, and it became important for me to be mindful of my interactions with them since they were heavily focused on these assessments. An additional challenge with this research was the risk of consuming too much time or resource on a small number of participants (Gans, 1999). However, one observed session per week for each case, the replication logic of the study design, and the multiple points of data collected mitigated this risk. Due to the small sample sizes, there was a risk that students may not participate for the duration of the study. This issue was addressed by allowing additional numbers of students to volunteer to participate in this study.

In addition, I included other strategies to ensure the credibility and trustworthiness of the study. Table 6 identifies those strategies. It adapts and modifies recommendations offered by Noble and Smith (2015, pp. 34-35) for the specific context of this study.

Table 6

Strategies and Methods to Ensure Credibility of Findings

Strategy	Method
Accounting for personal biases which may have influenced findings	Cross referenced my field notes taken in the field against the re-written field notes at the end of each day and the videotaped sessions
Acknowledging biases in sampling and ongoing critical reflection	This process occurred throughout the entire study. It involved re-checking the methods of data collection and field notes and being adaptable within the observed sessions
Meticulous record keeping	Field notes, typewritten field notes, videos, transcripts, critical episodes, vignettes, customised discourse analysis spreadsheets, and Nvivo were utilized to track analysis and findings
Seek similarities and differences across accounts	A multiple case study design provided opportunities to integrate the findings from each case in the findings analysis
Including rich and thick verbatim descriptions of participants' accounts to support findings	Thick descriptions and participants' accounts were included in the vignettes surrounding the critical episodes and addressed by research questions
Respondent validation	Students and instructors were invited to review their interview transcripts and to ask me questions at any point during the study
Data triangulation	Based on the multiple case study design and due to the multiple modes of data collected, data were triangulated

4.6 Ethical Considerations

Throughout the duration of this study, multiple ethical practices were undertaken. In the following sections, I discuss ethical considerations for gaining access to the learning spaces and students, ethical challenges, and additional consents required to conduct this study. However, first, I sought ethics approval from both Massey University and Unitec. Massey University's Northern Human Ethics Committee granted this research study first (approval NOR 18/14, Appendix A) and subsequent approval was received from Unitec's Research Ethics Committee (Appendix B). In addition, I received an extension of my ethics approval due to the Covid-19 pandemic (Appendix T).

4.6.1 Gaining access to the spaces and students

It was important to understand Unitec's organisational structure and to obtain the appropriate consents to conduct this research (Figure 13). The structure contains multiple networks divided into Practice Pathways. For example, a network named as Engineering, Construction & Infrastructure consisted of Engineering, Vehicle Systems & Materials and other Practice Pathways. Each pathway was led by a programme head or Head of the Practice Pathway (HoPP). Additionally, contained within each network there were many programmes with programme leaders and instructors.

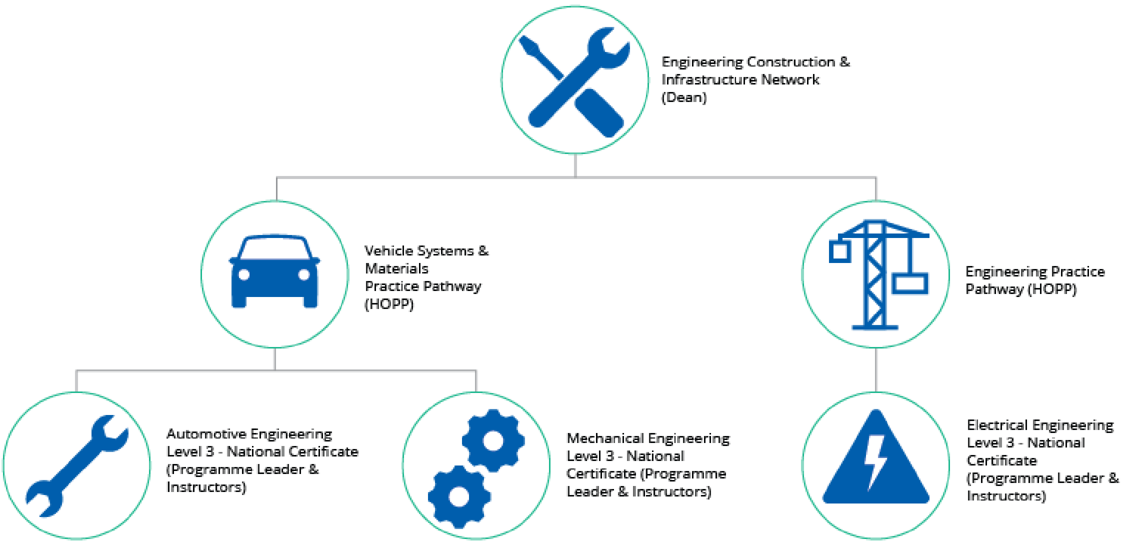


Figure 13. Unitec organisational chart.

Through my work at Unitec and prior to this research study, I met some of the programme leaders and instructors involved in the Level 3 certificate programmes, specifically Mechanical Engineering and Automotive Engineering. Once ethics permission was obtained and network introductions were made through the HoPPs, my proposed research was introduced to lecturers and participants. At that introduction it was clarified that the research would not be connected in any way to my work responsibilities at the institution. It was also made clear that confidentiality and anonymity were to be maintained throughout the data-collection process and in the written thesis. Instructor observation consent forms were signed and collected and the first date of my introduction/attendance to the classes was scheduled (Appendices D, E and F). Each selected cohort was introduced to the research by instructors on the first day of the class for the term and student participant volunteers were sought (Appendix G). All students in each cohort received the student information sheets and, if they chose to participate, were provided Student Observation Forms (Appendices H and I).

4.6.2 Ethical challenges

Observing and participating with only four students per session within the larger context of up to 30 students in a session proved challenging. Sometimes student participants worked in close proximity with other students who did not volunteer for the research, such as the electrical workbenches. If I was unable to reposition the video camera to exclude the non-participant(s), I would move on to another study participant. It was sometimes challenging to tape the students because other non-study participants would be working with them. Sometimes I would have to re-explain my research to interested students so they could understand why I was observing them. Other times it was challenging to keep up with the participants' dialogues since the course content was foreign to me and I needed some understanding to gauge the flow of discussion and activity. However, in the process of re-writing field notes online at the end of the day, I was able to research the course content to gain an understanding of it.

4.6.3 Additional consents

Based on feedback from the Human Research Ethics Committee at Massey, it was requested that I work with a Māori advisor. Once the advisor accepted my invitation to participate (Appendix C), I was advised to introduce myself to each cohort with my pepeha, a traditional Māori introduction acknowledging myself and my family in te reo Māori, the Māori language. Whilst I did not collect data on ethnicity, by reciting my pepeha, I acknowledged tikanga Māori or Māori customs to the student cohorts.

4.7 Data Storage

Data for the digital video, artefact collection and creation, and the interviews were stored on my password protected computer, on a password protected external digital hard-drive, and in a secure, cloud-based storage service known as DropBox. The field notes were created on a password protected Google account. Physical documents including the signed consent forms were stored at the Albany campus in a locked filing cabinet accessible by my supervisors and me. Data were stored in cohort-specific file folders and organised according to themes that emerged from the data collection. At the end of each data-collection week, digital photos were taken of the physical documents and catalogued and stored on to the external password protected hard-drive and uploaded into my DropBox account. Audio files of the interviews were taken on my smart phone and then transferred to my password protected computer, external hard-drive, and DropBox account.

4.8 Advantages of the Data-Collection Methods

The collected data provided a significant volume of information. A pilot study would have aided in the development of targeting the data collection methods for this study and to check if the collection methods, interview instruments, and questionnaires were understandable. However, due to resourcing and time constraints, one was not undertaken. Nonetheless, through an interdisciplinary view, I accounted for the learning dialogues by including a deep look at the designed elements of the course, the student groupings and the spaces used to foreground them. As a participant observer, I was able to query students' activity and utterances for clarity. This allowed students to get to know me and establish trust over time. Collecting a wide range of data also helped in that if I missed something during the session, I still had other ways to check the data. The methods of student observation, field notes collection, artefacts collection and semi-structured interviews allowed each case to be triangulated with multiple data sources. This methodology was also strengthened by using a multiple-embedded case design so that findings from each case were compared for similarities and differences.

4.9 Conclusion

In this participant ethnographic research, the social practices relating to learning dialogues and activity were shared and observed. The participants' experiences, knowledge, views, perceptions and reflections were crucial for this research (Patton, 2015). The choice of interpretivist research enabled me to understand the complexities of the designed aspects of trades environment, how students worked together, and how the artefacts impacted and mediated students' learning talk and activities. The basic qualitative/interpretive methodological approach was chosen to focus on the events, processes, and activities and how they were perceived by the participants and mediated by the artefacts and digital and physical spaces.

The interdisciplinary lenses of dialogism and entanglement theory provided a direction for the methodology to be employed and was designed to understand the emergent dialogic activity, insights into participants' perceptions, and to observe how material assemblages formed within learning entanglements. The data-collection methods supported this methodology and included student observations, field notes, artefact collection and semi-structured interviews.

In the next chapter, I present the first case, Automotive Engineering.

5 Case One–Dialogic activity in an Automotive Engineering Tertiary Learning Environment

The first case study presented is the Automotive Engineering Level 3 course. This course covers the skills and knowledge required of students to secure an entry-level position as apprentices in the automotive industry. In this chapter, I discuss the role of key elements in the design of the course, based on an interview with the instructor, and provide vignettes that focused on the role of materials and the role of physical spaces in learning entanglements. Students' reflections about their activities are provided in relation to their experiences and key design elements.

5.1 Designed Elements in the Automotive Engineering Course

I begin by examining the instructor interview to understand some of the key elements in the architecture of the course. This included designed aspects and students' co-configuration of both the digital and physical environments. Being a hands-on, project-based course, tasks were mostly designed in the form of workbooks and handouts (epistemic design) which scaffolded students' learning towards their assessments. Complementary information or course content was provided by the teacher via the Moodle learning management system (LMS) (set design). The assessments included a 50% weighting on the practical tasks, a 35% weighting on activities towards underpinning knowledge, and a 15% weighting for an embedded project which covered business practice and social responsibility. Two of the assessment tasks were conducted in face-to-face sessions and the 15% project was conducted by students independently.

The instructor of the course explained that the tasks for shared knowledge and inquiry were embedded in the project work and assessment tasks and that they mainly consisted of practical, hands-on tasks that encouraged students to engage with automobile systems such as electrical and brake systems (epistemic design). He pointed out that "another aspect we are covering there is a need to learn or work collaboratively; so, we put them in groups of at least three, sometimes they work in pairs" (social design). However, due to the overall social nature of the cohort and the nature of the assignments, as I observed in the sessions, students moved fluidly amongst different groups and interacted with each other if they required tools, equipment or information to aid in their work (emergent activity). The instructor described the process of their collaboration: "they work together, and they discuss the topic, break it down, and they take little pieces to work with; then they come together and compile the whole project". That is, students took responsibility for part of the whole project and, through this activity, engaged with each other to complete the project. Sometimes, the open learning spaces (set design) or areas of Mataaho enabled students to see and hear if others needed assistance and they then provided opportunities to do so. As the instructor explained, the cohort "sort of stick[s] together as a big team". My observations suggest that this cohort had a well-established culture which is crucial for enabling productive dialogues. As such, opportunities for engagement in learning entanglements and dialogic activity were plentiful. Interestingly, the instructor was aware that sometimes students engaged with others in the cohort when working on their own automobiles outside class time. This practice demonstrated a certain level of motivation to apply their learning and engage with their community of practice outside their face-to-face sessions.

In addition, opportunities for self-reflection were included in the design of the course, in the form of practical worksheets (epistemic design). The instructor explained that the workbooks contained sections for students to write their reflections in which they "basically tell us what they have learned…and if there is anything new they have learned." Furthermore, the instructor pointed out that if students in this cohort needed to use other resources, they sought knowledge from sources outside of class, by checking websites and "conducting their own personal investigations." This included information beyond what was designed as part of the course such as the LMS content, workbooks and worksheets. That is, students sought content external to the course from their peers, Google and their own student communities and networks (emergent activity).

In terms of overall course improvement, the instructor noted that this aspect was ongoing and was being reviewed fortnightly by the team of instructors who redesigned the programme. The instructor explained that the course's success was based on lifting student retention, and, in some cases, this required intervention on his own behalf and special exceptions to help students succeed.

Having described some of the key course elements related to set design, epistemic design, social design and students' co-configuration, I now focus more closely on elements in set design and emergent activity, as I examine the role of the materials and their properties within learning entanglements.

5.2 The Role and Properties of Materials in Learning

5.2.1 On a mistake

In the following, I describe a vignette that showcases the properties of an artefact when it is mistakenly employed.

5.2.1.1 Context

It is the beginning of the semester, and the automotive students are working on the electronics component of the Heating Ventilation and Air Conditioning (HVAC) course about electrical circuitry. Electrical circuitry is used to control heating and cooling systems in automobiles. Students had participated in a morning session and reviewed automotive electrical theory. They return from their morning break and change venue to the emulation lab in Mataaho to conduct practical activities relating to Ohm's law and electrical components. (Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.) The electrical componentry area of the lab (Figure 14) is demarcated by a series of rectangular work tables and desktop computers. It is a relatively quiet, smaller space with carpeted panels on the walls and carpeted floors. Students sit on chairs with wheels and were able to manoeuvre amongst each other as they worked. Personal protective equipment is not required in this area as hazardous machinery was not being used.

Figure 14. Electrical componentry area of the emulation lab, 307-2028.

Attached to each computer is a UniTrain board which enables students to conduct electrical experiments (Figures 14 and 15). Students insert various wires, switches, motors, lightbulbs and resistors into the board, based on activities provided through simulation software installed on each computer. Both the UniTrain board and the components are labelled clearly. Students work in self-selected pairs to complete a series of activities to wire electrical circuits. They use their course workbooks, activity worksheets and pens and, follow the procedures provided to conduct the activity.

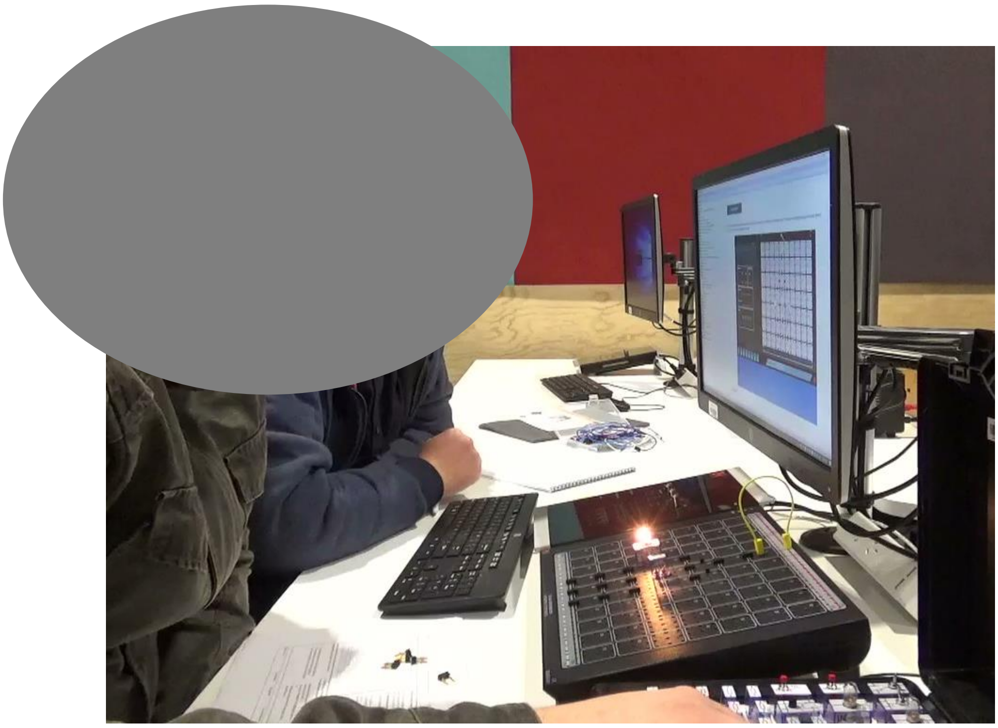


Figure 15. Students work with the UniTrain board.

5.2.1.2 Activity

Students were required to wire a lightbulb successfully with multiple resistors to the UniTrain board using instructions or procedures displayed on the monitor. Student 1 and Student 3 were working together when the UniTrain board started to smell.

Student 1 and Student 3 start coughing and waving their hands in front of their noses as soon as they sense an acrid, electrical burning smell. Student 1 swiftly extracts a resistor out of the UniTrain board. He shakes his hand and blows on it because it is hot.

The following dialogue occurred:

1. Student 1: Oh, is that… is that burnt out?
2. Student 1 and Student 3 laugh and cough because of the acrid, electrical burning smell.
3. Student 3: Someone sizzled the 33.

4. Student 1: Is it supposed to be 33?
5. Checking the online course materials, both read the computer screen again. Student 1 realises he inserted the wrong resistor, which was meant to be resistor 330, not 33.
6. Student 3: Yes.
7. Student 3 smiles and looks at Student 1. Student 3 laughs.
8. Student 1: No.
9. Student 1 starts to laugh.
10. Student 3: It said 33. And it was on 33.
11. Student 1: [States Student 1's name] can't read.
12. Student 3: Hey I'm blind, OK? How do you expect me to read that?
13. Student 1 turns his head sideways while looking at the monitor. Next from the other side of the space, Student 2 shouts out a sarcastic comment so the entire class can hear.
14. Student 2: That explains the burning smell!
15. Student 1 and Student 3 turn around in their chairs to look at Student 2.
16. Student 1: Yeah, I read 33.
17. Student 3: And he couldn't see the 0.
18. Student 1: And I couldn't see the 0.
19. Student 1 and Student 3 turn back to their UniTrain board and computer. Student 1 picks up the burnt resistor, analysing it, shaking it to cool it and quickly passes it from hand to hand.
20. Student 3: Woo – that's hot.

The student misread the instructions and inserted the incorrect resistor; it overheated and began to melt.

5.2.1.3 Analysis review

The UniTrain board, the online instructions, the activity of wiring the board, and the students provided the context for this entanglement. The students checked the software instructions and compared it to the UniTrain board and components to diagnose what had caused the burning smell (lines 1 – 20). The process of comparison involved the use of the students' reflection and inquiry as they diagnosed the issue. While the instructions were not literally speaking to the students, the instructions did provide the students with a procedure as to how to conduct the activity. The labelling on the UniTrain board and the labelled componentry enabled the students to match, or in this case mismatch, the information and instructions provided from those on the computer. This episode illustrates how students' experience of an error has the potential to create opportunities for engagement in shared inquiry, as students attempted to understand what went wrong in an activity. Materials played a key role in alerting the students through an acrid, electrical burning smell indicating that something was amiss.

In addition, the verbal exchange provided evidence of shared knowledge and reflection. The students spoke to each other about resistor 33 and reconfirmed through utterance that it was incorrectly used. The embarrassment yielded through the dialogue and activity, and enhanced by someone at another table, added to the moment. The smaller working space located within the emulation lab and the acrid smell alerted the third student and created an opportunity for incidental learning. That is, Student 2 participated in the moment irrespective of the fact that he was seated at another table. Student 3 later reconfirmed this moment and its significance in his self-reflection questionnaire for the day by stating, "don't blow things up," in response to how he could improve his learning in the future. He also stated that he "improved through errors" in terms of his course work for the week. In addition, he identified that his questions were about how he "blew the resistor up," meaning he focussed on determining why the circuit started to melt. This appeared to be a significant activity and moment for him since it involved reflection, shared inquiry and shared knowledge, all evidenced in his self-reflection questionnaire responses.

Hodder's (2012) equation: "E + fittingness + conjunctural event -> problem -> fixing -> solution -> E'" allows a close examination of dependencies between human and things. This specific entanglement included an HT (Human-Thing) dependency because the student (H) relied on instructions and the resistor (T) to perform a task. In misreading the instructions, the resistor (T) was impacted, interrupting the purpose of the activity. Humans were acting on things to try to achieve a certain result. But things "reacted" (conjunctural event) alerting humans to the fact that the procedure was not working (problem). The burning of the circuitry indicated a problem had emerged which needed to be immediately addressed. In this case, the properties of smell and the sound of sizzling and heat from the resistor played a significant role in the entanglement, signalling to students that an action was needed. That is, the properties of the materials caused the conjunctural event, which needed fixing, prompting dialogues between the students. Evidence of this interplay was provided by student talk such as "I'm blind" and "wow, that's hot". This vignette illustrates how the properties of materials in learning mediate and impact students' dialogic activity.

5.2.1.4 Student perspectives

The student interviews provided insights into their perceptions about working with artefacts in their course and their experiences with learning entanglements such as in the previous vignette. The student participants unanimously favoured working on automobile engines (physical artefacts) including rebuilding and dismantling them or using diesel engines. In fact, one student said that "it's something I've really wanted to learn for a long time, and I never had the funds or experience to do it before." Aside from working with engines, the students enjoyed the process of assembly and disassembly of the engines and its parts or materialities. The students used phrases such as "taking apart and putting back together again" or "rebuilding" and "knowing where things go" or described the process of engine assembly as “when you get underneath it, and you actually get your hands dirty and stuff…that’s cool.” These students’ perceptions highlighted the point that students’ interests lay not only with the engines themselves but also in assemblages of things and their material properties, working together.

On the other hand, the students’ least favoured activities in Automotive Engineering involved working on the heating, ventilation, and air-conditioning (HVAC) unit, the Moodle LMS and the theory and quizzes which were delivered through the LMS. The students did, however, seek information from programmes in the online environment which included using Google’s search engine and the use of an industry-wide application called Autodata. Autodata provides technical data on cars and car parts for servicing in the workplace. One participant found the estimation calculators contained within Autodata useful for creating invoices. He described it: “I have this brake pad I gotta put on. It’ll show you how much time it usually would take, how much it usually would cost plus the working hours.” By providing an opportunity for the student to create an artefact by modelling how to do it with the calculator, the Autodata, as an online digital tool, modelled and mediated the student’s creation of a dialogic artefact. Thus, the artefact was used as a means of communication, in this case an invoice.

Next, I present a vignette that demonstrates how a reflection emerges as part of dialogic activity.

5.3 Reflections About Artefacts

5.3.1 On a torque wrench

Self-reflection is a significant component of dialogic activity. It may occur as an utterance or manifest within the mind. It may present as a written creation. It may also be part of the process of creating a physical artefact.

5.3.1.1 Context

It is mid-semester, and the students were tasked with the disassembly and re-assembly of petrol engines for the APTE3103 Engine Technology course. Theory had been taught in the online component of their course and students were tasked with conducting the practical activity while filling out their Engine Technology workbooks. At the start of the session, the instructor provided a 5-minute overview of what the students were expected to work on, and he continued to provide support for students as needed. The students were in a heightened mood and the workspace was buzzing with activity and noise as the students hovered around the engines and engine parts while reading specifications manuals, discussing their work, doing their tasks, and writing in their workbooks. Students were situated in 307-1036, Dismantle and Reassemble area of Mataaho which is occupied by approximately 15 engines mounted on moveable stands positioned next to very large, industrial workbenches. On the top of each table students placed a long piece of butcher's paper; this was used to place the engine parts on and to notate them. In self-selected pairs, the students laid out their toolboxes and gear alongside the engine parts on the table (see Figure 16).

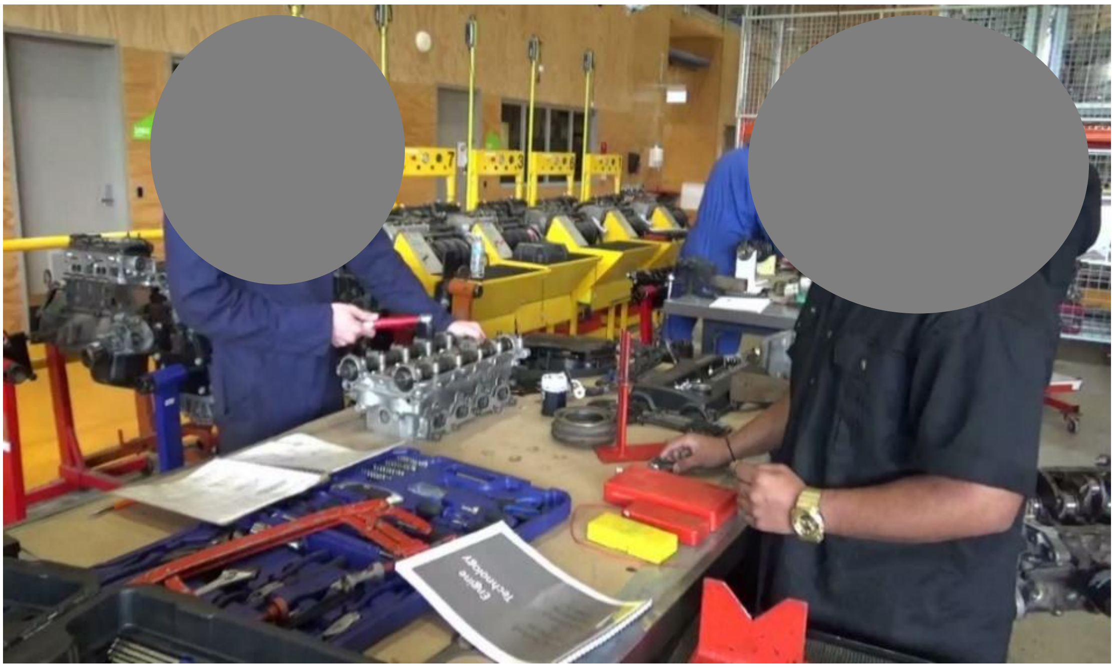


Figure 16. Engine dismantle and reassembly area, 307-1036.

5.3.1.2 Activity

Students were reassembling the shims and springs into the camshaft by inserting them into the engine and then tightening the bolts to secure them. This is the part of the engine where internal combustion takes place to power the pistons, which power the motor. The camshaft was placed on the table and a student was tightening bolts on it. The students alternated seamlessly between reading the specifications manual and turning to look at the camshaft as they individually tightened the bolts in the correct sequence and pattern. I began to wonder how students could know if they were missing a part, given the chaotic appearance of parts laid out on the butcher paper with tools and workbooks in the mix, within a small working area.

The following dialogue occurred:

1. Researcher: Can I ask you guys a question?
2. Student 4 & Student 15: Yeah.
3. Researcher: Is it hard to tell if there are parts missing from that?
4. Researcher is pointing to the workbench where the parts are laid out on butcher paper.
5. Researcher: Do you have to ask the instructor or how do you figure it out by context? How do you go about not missing information?
6. Student 4: If you had it correctly laid out, like we have, definitely not. Because you know what went where, like these. You know you need all of the shims in for the springs to be compressed.
7. Student 4 is showing the researcher the shim for the spring.
8. Researcher: Right.
9. Student 4: So, you're not really going to miss anything there because the spring is going to be loose.
10. Researcher: Right.

11. Student 4: It's more like—is that bolt tight?

12. Researcher: Yeah?

13. Student 4: That's what I freak out about every time. Like oh, did I tighten it?

14. Researcher: Yeah?

15. Student 4: That's why you need one of these, it's a torque wrench.

16. Student 4 presents to the researcher a torque wrench.

17. Researcher: Oh, is that what that is?

18. Student 4: Have you ever seen one of those before?

19. Researcher: No.

20. Student 4 looks across the workbench to address Student 14.

21. Student 4: How does it work?

22. Student 14: I'm not too sure but like. I think there's a pin inside that kind of like you set the right spec and once it feels like the certain torque, it kind of stops it.

23. [Torque is a twisting force applied to bolts or how tight a bolt is fastened to an engine or part].

24. Student 4: Yeah, stops it. So, you hear that click, click, click.

25. Student 14: Click, click.

26. Researcher: Yeah. You tighten it up.

27. Student 4: But that means you have tightened it. Yeah, so that's why you have all the torque specs everywhere you see.

28. Student 4 looks at the engine specifications manual and looks up and down the page while pointing to multiple specifications on the pages that are open.

29. Researcher: So, you change the, what's the unit of measure on that?

30. Student 4: Newton meters.

31. Researcher: N e u t o m e t e r s [sic]? I'm just trying to spell it.

32. Student 4: Just go NM.
33. Researcher: But that is a really critical piece for you to have. To be able to do this work.
34. Student 14: It's so helpful.
35. Student 4: Yeah, it has to be the correct joint spec because if it's too loose…
36. Student 14: You can't estimate from your own force.
37. Student 4: Yeah, if it's too loose it could fall out and if it's too tight you could snap the bolt.
38. Student 14: Yeah, if it's too tight you could, like, do stuff.
39. Student 4: You could do critical damage either way.
40. Student 14: Even when you try to run your vehicle after that, it doesn't.
41. Students walk over to the workbench table and exchange tools.
42. Researcher: Cool. That's pretty awesome.
43. Student 4: Yeah, pretty handy to have, for sure.

5.3.1.3 Analysis

As an engine runs, it becomes hot and vibrates; this environment can create conditions for fasteners (such as bolts) to loosen and potentially become unsecure. It is critical that they are tightened in a certain pattern, order and level of pressure (Newton meters) (see Figure 17). If they are not fastened in the correct pattern or with the appropriate pressure, there is potential for catastrophic loss to the engine and coolant systems. At the outset what seemed like a basic activity proved to be highly significant to the student, as demonstrated through his discussion with me and as shown in his reflective questionnaire. The student reinforced the importance of this by stating "that's what I freak out about every time". By saying "it's more like – is that bolt tight?," he acknowledged the reflective act of querying the status of the bolts. This dialogue demonstrated the importance of an artefact to the students' work, or the HT dependency (Hodder, 2012). The dialogue indicated that both students have thought or reflected about the importance of a torque wrench and expressed their importance of the materiality of engine assembly. The students built upon each other's statements in lines 31 to 39, in this reflective vignette, whilst working on their engines. From a dialogic viewpoint their activity may be described as a cumulative shared reflection. The space in which the students were working played a role in this vignette too, since Student 14 was in proximity to our conversation and not only interjected his comments into the conversation, but also finished or augmented Student 4's statements, building upon them to describe the consequences of not using the artefact correctly.

The torque wrench, work bench, butcher's paper, engine parts, specifications manual, pen and the activity Student 4 conducted with the artefacts created an environment (or dialogic space) for shared self-reflective dialogic activity to occur. He double-checked the specifications manual to ensure he was applying the correct pattern for the application of the bolts to the engine. That is, the student checked or inquired about the information or knowledge conveyed in the specifications and in that act reflected to make sure he was conducting the task appropriately. The importance of this activity was highlighted in Student 4's self-reflection questionnaire for the day as he noted he "helped others with questions about torque specifications," indicating his thinking about the torque wrench and sharing its importance and knowledge about it with others.

Figure 17. Torque wrench.

5.3.1.4 Student perspectives

Interestingly, reflection did emerge throughout the student activity during face-to-face sessions. The instructor volunteered in his interview that self-reflection arose through students' learning activity in class, by what they had read on websites, and by their own personal investigations alongside the designed reflective tasks part of the workbooks and worksheets. In this situation, reflection opportunities were included as part of purpose-built tasks. But reflection also occurred during those moments when it arose as an incidental or implicit dialogic activity on behalf of the students, such as described in the "On a torque wrench" vignette.

While the student interviews did not specifically focus on students' reflections about their use of artefacts and their activities, they did show that the students preferred to be working on things and that it was through their collaborative activity that opportunities arose for reflection. Collaboration played a significant role in the students' activities. In addition, as a part of their inquiry and as a part of knowledge gathering, or when they had questions about course content, students could seek answers from Google, government websites, their teacher, and peers, in mixed modalities. Two of the participants cited the instructor as the main source for information. However, it was also found that students would share information with each other in many ways. One student noted how they would "bounce ideas off of each other"—a self-reflective metaphor about the nature of his discussions. Another student described the act of sharing information as a form of "insurance" so he could make sure he was in the right direction with his activity. The act of gaining insurance to double-check his understanding and exchanging ideas showed that self-reflection may be an equal participant in the collaborative and shared act of dialogic activity.

One participant volunteered that he was involved in a Facebook messenger group that consisted of students from his cohort and other cohorts in Automotive Engineering and that his involvement enabled him to share information as well as ask about course content. While most of the content was identified as "fun" in the Facebook group, the student noted there were opportunities to share and collaborate with others with a variety of background experience in this space. This activity effectively extended his community of practice and provided opportunities to engage with the tools, artefacts and language relevant to Automotive Engineering.

5.4 The Role of an Open Learning Space

5.4.1 On a disruptive artefact

The following vignette describes a learning entanglement within an open learning space.

5.4.1.1 Context

It is the last few weeks of the term, and the students are getting tired. The instructor gathered the students for the practical session and reminded them there are 5 weeks left in the course and they must turn in their workbooks to be marked. About half of the class attended the practical session in the morning on this day. Today students were continuing their work on the Engine Technology course in area 307-1034, the Chassis, Engines and Electronics area of Mataaho. Technicians drive fully functional automobiles in and out of this space, and this allows students to work on the designated tasks. Three vehicles were provided for the day's practical session. Also included were large moveable, multi-drawer toolboxes positioned next to each vehicle. It is an open area and students were assigned to work in pairs.

5.4.1.2 Activity

Students were tasked with conducting a compression test on the engine and were working in self-selected pairs. A compression test is used to check the condition of the engine's valves, valve seats and piston rings. For this procedure, each spark plug is removed, and the test is conducted. The students are using a snap-on spark plug socket wrench to remove a spark plug from the engine. The snap on spark plug socket wrench has a rubber component inside of it which is meant to adhere to the spark plug, sticking to the spark plug to it so it can be removed. Since there were three vehicles in the area at the time, student pairs had to take turns running the compression tests. The snap-on spark plug socket wrench was not working properly (Figure 18).

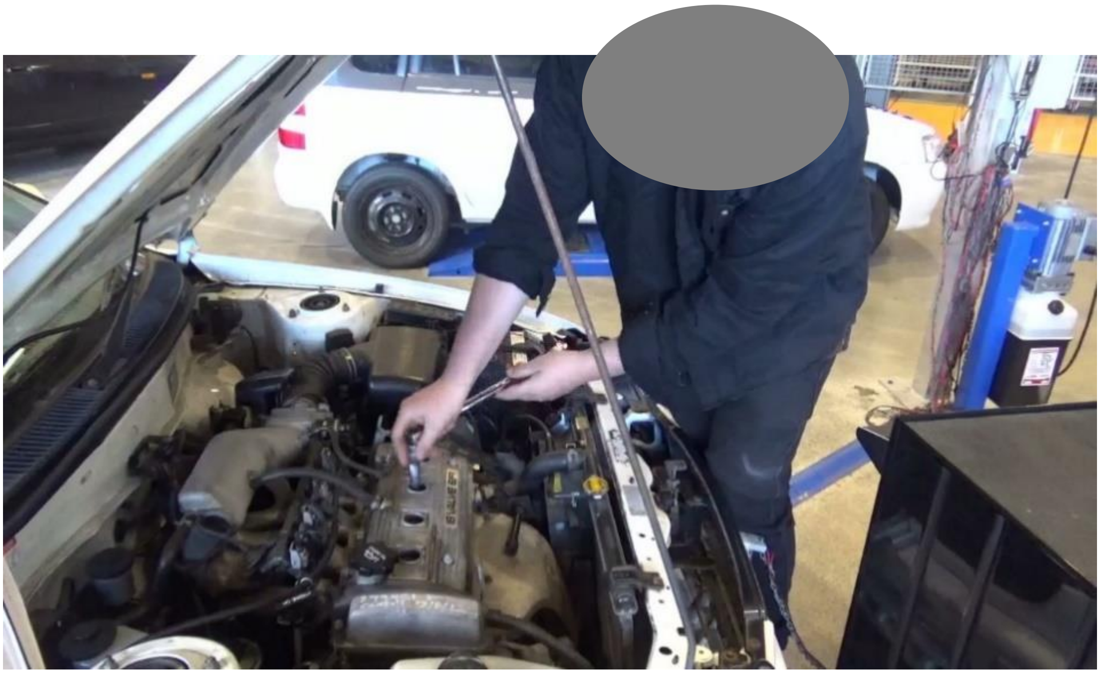


Figure 18. Student 2 Using the snap-on sparkplug socket wrench

The following dialogue occurred:

1. Researcher: Why do you think that's not coming out?
2. Student 2: 'Cause you can never work on a car without having problems.
3. Researcher: Oh yeah? Is that Murphy's law of cars? So, you're always figuring stuff out?
4. Student 2 is still trying to get the sparkplug out. He made multiple attempts and is getting frustrated.
5. Researcher: Well, that almost came out. Is that because it's not magnetic on the inside?
6. Student 2 tries to unscrew the spark plug again.
7. Student 2: No, it's not magnetic. That's the point. We need a magnet; but, no, we get rubber instead. We're just supposed to make it stick somehow.
8. Student 2 attempts to unscrew the spark plug again.
9. Researcher: Oh.
10. Student 2 tries to unscrew the spark plug again.
11. Student 2: And if I press too hard, I will break the spark plug.
12. Student 2 makes another attempt.
13. Researcher: Oh.
14. Student 2: I feel like having an intervention right now.
15. Student 2 tries again and is getting frustrated.
16. Student 3 hears the conversation and walks over to ask a question.
17. Student 3: Is that the half size? Where's the number 3?
18. Student 2 tries to unscrew the spark plug again and is almost able to extract it.
19. Student 2: We're getting there. We're getting there. Come on!
20. There are multiple more attempts to remove the spark plug. Student 2 is becoming more frustrated. Student 1 can tell there is an issue, and he walks over.
21. Student 1: Do you want some help?

22. Student 2 tries to unscrew the spark plug again.
23. Student 2: With the engine or my life problems?
24. Student 1: Both.
25. Student 2: Aw na bro. Why not. Dual purpose. I need some super long nosed pliers.
26. Student 2 tries to unscrew the spark plug again.
27. Student 3: What about a magnetic screw driver?
28. Student 3 hands Student 2 the magnetic screw driver in the hopes the spark plug will stick to it and he can pull it out. Student 2 attempts to remove the spark plug with the magnetic screw driver. He is still angry and frustrated.
29. Student 3: That work?
30. Student 2: No. They [spark plugs] weigh too much.
31. Student 1: I'll go get my toolbox then.
32. Student 1 gets his toolbox out of the car that he is working on and returns with a magnetic spark plug socket wrench; they are finally able to remove the spark plug. Student 2 continues with the task of running the compression test.

5.4.1.3 Analysis

Even though the students were expected to work in pairs, other students could see and hear that Student 2 was having problems with the removal of the screwdriver. The space was sufficiently open to invite the participation of others when an issue was encountered. In this learning entanglement, the object of the task, the compression test, was interrupted by a broken tool. The conjunctural event of the spark plug (T) not being removed, and the student (H) not being able to remove it, occurring in simultaneity within the open learning space, caught the attention of two other students (H), who came over to help fixing the problem. The classroom space played a role in this entanglement and, again, there were human and things dependencies at play.

This scenario exemplified shared inquiry and shared knowledge in a cumulative way, as students trialed different tools, namely, a magnetic screwdriver, and a magnetic spark plug socket wrench, to remove the spark plug. The artefact (T) that was intended to enable the flow of tasks required, disrupted the activity, manifesting as the conjunctural event in this TH entanglement. The unplanned issue of a tool not working properly within a large open space, provided an opportunity for collaboration to solve the problem even when it required multiple alternate tools or artefacts until the correct one was sourced from a student's personal tool kit. In his self-reflection for the day, Student 2 pointed out that he needed "more enthusiasm" to improve for the next session. Clearly, he was not to blame for the incident, but even so, he was frustrated at how the tool disrupted the flow of his work and in the end the team of students came together to solve the problem with questions, advice, and knowledge (dialogic activity) and finally, a screwdriver (tool or artefact) that worked. This communal involvement effectively ended the disruption and re-engaged the flow of activity to complete the compression test within this learning entanglement.

5.4.1.4 Student perspectives

This vignette showed how open physical spaces can act as mediational means within learning entanglements. Interestingly, the student interviews provided a mixed response about the spaces students used in Mataaho. One student stated that there was an "over-exaggeration of PPE [personal protective equipment] use". Whereas another student said they preferred the hands-on activities of working on cars instead of talking about it. One student noted that "you can actually work on a car" and get into "the physical aspect of it". That is, the activity alongside the learning dialogues conducted in the open physical spaces were preferred over theory or required conditions, like using PPE, to participate in the space. Overall, the students enjoyed the workshop environment including the tools utilised and demonstrations conducted within them if they did not disrupt their learning-by-doing.

In addition, the students' favourite learning spaces included the emulation lab, the canopy, and the engine stands in the disassembly and reassembly area. For two of the students, the least favoured physical spaces included the breakout rooms in Mataaho, with one of them noting that more gear should be in those rooms to look at. Interestingly, one participant raised concerns over the building's ventilation, noting that at times strong smells exuded from activity such as "cutting metals, using ban saws and burning electrical smells" from motors and these sometimes permeated the full building. Physical properties of materials in different states such as burning, like those in the building, have the potential to act as a participant in that space and frame the students' dialogic activity. The point raised by the student highlighted his categorisation of space, in this instance, as one that embodied a material property. Another student pointed out that his least favoured space in Mataaho included broken equipment in the brakes and the steering components area. As with the student above, this student identified the space by the broken artefacts (located within the space) and not the space itself. These two spatial identifications suggest that space may be associated with tools or the properties of materials if those tools or materials are sufficiently significant to disrupt student learning or if they are perceived as part of a learning entanglement. Equally, space may create environmental conditions within which entanglements emerge. Importantly, properties such as odours and noise have the potential to influence entanglements.

5.5 Findings Summary

Learning activity emerged as part of learning entanglements for this collaborative cohort. The quality of materials and the embodied experience of thinking, doing and engaging with tasks, materials, spaces and people impacted the students' dialogic activity. It was found that the artefacts, their properties, and their materialities degraded or changed over time, such as the broken spark plug socket wrench, and provided different examples of learning entanglements, such as making a mistake. It was also found that digital tools, like Facebook and Autodata provided the students with a means to participate within their student community and to engage with digital knowledge artefacts. These digital tools also provided opportunities for shared knowledge and inquiry.

In addition, this case showed that reflection is an important part of dialogic activity. It may manifest itself during shared collaborative activity or as a personal activity undertaken by the student. It is within a reflective instance, that a student checks his knowledge as a form of insurance to assess and augment or discard his knowledge in comparison with the knowledge of others. Materials sometimes come in support of learning, such as the software system Autodata or the tools, such as a torque wrench.

The Automotive Engineering students preferred working with their hands and their tools and conducting their tasks with engines were the most favoured of activities if there were no course interruptions, such as work on the LMS or theory during their face-to-face sessions. The learning spaces available to students performed a critical role. The automotive environment is smelly, oily, and loud and replete with artefacts. In that environment, the senses played an important part in relation to noticing the qualities of the materials and fuelled the dialogic activity of the students. At times, the material properties experienced by students, and enabled by the large space, generated student dialogic activity. Of interest was the observation that students sometimes associated their learning spaces with the broken artefacts contained within them instead of the physical learning space.

5.6 Conclusion

This chapter provided examples of dialogic activity within the Automotive Engineering case. It showed that the course design enabled students to engage within the socio-material aspects of their activity and dialogues. It also showed that the quality of materials, reflections about artefacts and the role of learning spaces mediate students' dialogic activity.

The following chapter introduces the second case, further illustrating dialogic activity in this study, the Electrical Engineering case.

6 Case Two–Dialogic Activity in an Electrical Engineering Tertiary Learning Environment

The second case study for this research is the Electrical Engineering Level 3 course. This course was designed for students to become Electrical Engineering apprentices and teaches the skills and knowledge required to take the capstone exam, which when passed, qualifies students to become electrical apprentices. In this chapter, I discuss the instructor-designed aspects of the course and investigate the role of materials, the students and learning spaces within learning entanglements. I also offer student reflections about their activities as they experienced them in relation to course design.

In the first section below, I discuss the findings from the instructor interview.

6.1 Designed Elements in the Electrical Engineering Course

Since the Level three Electrical Engineering course was new, the instructor described the course as being modified during its progression and as a blended design. He reflected on the importance of including more videos online (epistemic design) in the Learning Management System (LMS) (set design), to offer "small videos around the practical stuff we do" and "some of the problem solving so that they [the students] have some steps they can go through when they hit the wall in the practical sessions." He also added that more videos (epistemic design) would ease the need for his expertise in the practical sessions, since he was the main informational resource for the students at that time. In addition, he said more online videos would aid student confidence in assessing and identifying challenges with problem-solving electrical tasks.

The instructor explained that his course design included 50% student tasks (epistemic design) in practical sessions with the remaining 50% dedicated to a combination of the theory sessions and the materials provided online (set design). The theory sessions matched and directly followed the practical sessions on each day. Because it was a new course, this arrangement enabled the instructor to make changes to the course to adapt to students' needs. In terms of shared knowledge activities, the instructor felt that the students "learn a lot more off each other than me," drawing attention to the collaborative nature of the student cohort. In addition, the instructor indicated that "sometimes the answer[s] are right there next to them." That is, the close proximity of the workbench spaces (set design) meant that the students could observe each other's work, side by side, and at the same time the proximity provided individual students opportunities to compare their work with each other (emergent activity). I witnessed this activity throughout my observations. The students learned from each other by observations and by shared inquiry or emergent dialogic activity. Further, the instructor noted that the students shared information through conversations and arguments. He pointed out "it's really good. [He began mimicking a student's voice] Ah ha! That's the wrong answer!" [Back to his voice.] "That's the conversation you want to hear. Then a third person gets involved and they tend to do that when they have a discussion; they like to get someone on their side." He described student disagreements as an important aspect for students' individual decision making within this environment.

The instructor described the face-to-face practical sessions as "chaos." However, while the environment appeared to be chaotic, it was very collaborative. In the practical sessions, students assembled and reassembled things, solved problems, borrowed tools from each other, laughed and talked as they conducted their work. Based on my field note observations, the students were deeply engaged in learning dialogues while working with schematics. As the students worked, they dipped in and out of their Google, FB groups or the LMS (digital spaces) and sought feedback from their peers face to face, with the instructor, or digitally, all in simultaneity.

Importantly, the instructor noted "there is a health and safety thing that keeps me on edge." In the practical sessions, the instructor always remained on alert to immediately press the kill switch to prevent electrocution. As he described it, he conducted his course within a "life and death" environment. However, he said that students knew they must always conduct two or three key tests, such as earth and insulation testing, each time they started a project. These are key tests required to be conducted before students engage in their tasks for the day and on site for every work project they are assigned.

In terms of designed activities which enabled self-reflection, the instructor described an allocated moment that typically occurs within the first 10 minutes of the practical sessions as a "kind of peace" in which the students are self-reflecting and thinking (epistemic design). Both these activities are dialogic. "It's a different energy, they're like right, what do I need to do? Back with what's in front of them and try and reflect back on what they did last week and what they need to change." This example illustrates how the designed tasks (epistemic design) provided opportunities for the students to reflect, revise and change their work as the tasks become more sophisticated and as the course progressed. For the instructor, reflection was inherent in the design of the tasks.

In relation to the overall course structure, the instructor indicated he wanted to improve the way in which the students engage with the course content (epistemic design), providing students with more autonomy and choice (social design) via the access of online video resources (set design). He also wanted to reduce the amount of time he lectured in the theory sessions. He wanted to design more group tasks (social design) in which students could work together on solutions from previous capstone exams (final exams). For him, course success was revealed through job offers for the students as apprentices. The instructor also volunteered that success was shown by students successfully wiring their boards by explaining that "some of them [the students] are really surprised when they [the boards] work." However, he emphasised that as a new course, its development was ongoing and that it continued to be a work in progress.

6.2 An analogy as a dialogic tool

6.2.1 On Flow

In the next section, I describe a vignette in which a student uses an analogy as a descriptive tool to explain electricity.

6.2.1.1 Context

It is the third week of the term for the electrical students and students are busy working on their electrical boards in the three-phase section of Mataaho; it is an active and lively space on this day. Students are happy and the positivity is palpable. Students are observed moving amongst each other and discussing their work as the instructor roams the space to assist those in need. They are tasked with using a schematic to wire their star and delta timer configurations. Star and delta timer configurations are used along with contacts to create switches to start motors. They provide different levels of power to start a motor. For example, a larger motor will require more power to start it. Contacts are used in these configurations and either allow or inhibit the flow of the power through the wires. A contact is either in a closed or open state. When the contact is closed, it completes the circuit and allows power to flow through. When it is open, the wires do not connect and the flow of power is ceased.

The contacts are shown in the wiring schematic or map (Figure 19) used to show the wiring configurations.

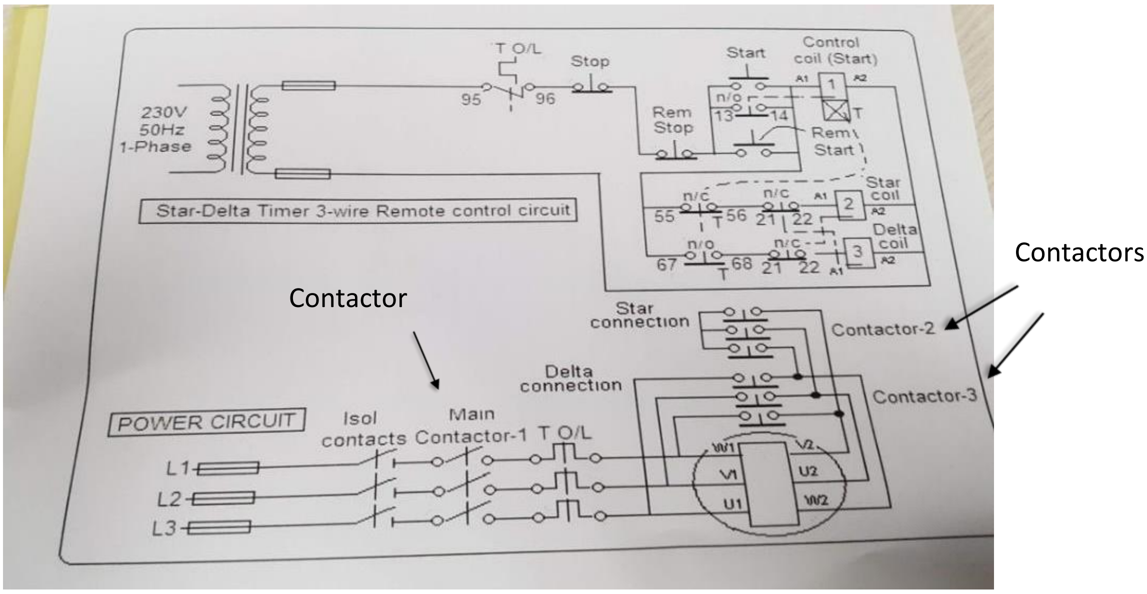


Figure 19. Star-Delta timer schematic with contactors.

6.2.1.2 The activity

As I began to film Student 13 for the first time, he spontaneously began to discuss his work. The following dialogue occurred:

1. Student 13: Yeah, I like electrical. It's cool.
2. Researcher: Um.
3. Student 13: It's kind of like a river, you know what I mean?
4. Student 13 connects a wire to the terminal.
5. Student 13: That's the way I look at it, anyway.
6. He faces the student next to him, Student 7, and grabs his wire cutters.
7. Student 13: Why can't I borrow your wire cutters?
8. Student 7: You can. It's just that I need to use them at the same time.
9. Student 13 clips the end of the wire and exposes the copper tip to connect it and returns his attention to our discussion.

10. Student 13: So then from looking at the schematic diagram I already know what contacts are which and where I need to put them. So, it's just a matter of going through the process and doing it.

6.2.1.3 Analysis

The student spontaneously volunteered his thoughts and insights in this activity. He used an analogy for electricity: "it's like a river, you know what I mean?" and perceived the wiring of his board as a configuration that either enabled or halted its flow. Much the same as a log jam might alter the flow of a river, for this student an open or closed control switch altered the flow of electricity. He checked that I understood what he meant by his analogy, a language tool, and he chose to ensure I understood him.

Although this vignette did not describe a particular conjunctural problem, it highlights the importance of the use of an analogy in the dialogic space in gaining shared knowledge and understanding. During this brief moment, he showed me his schematic as he compared it to his wiring board. He pointed out the flow of the connections in the diagram to where the flow of electricity was laid out on his board. That is, in his internal dialogic process, a reflective act, he checked or queried the schematic and compared it to his work conducted in his dialogic activity. Once he was finished with the wiring, he tested the board and found that the motor worked.

In addition, whilst working on this board, I observed that Student 13 experienced his own physical flow of activity as he spoke. He connected the wires to the contactors effortlessly as he spoke. As he continued to share his reflections, his activity remained uninterrupted. It was clear that the physical flow of activity mirrored his utterances in a symbiotic way. The schematic directed the student's internal dialogue into embodied activity for wiring the board, demonstrating that his thinking and doing, or dialogic activity, were inseparable. Student 13 was in a jovial mood and his reflection for the day revealed that he did not need to improve and that he was doing "really well at the moment" in class. My observation supported his reflection.

6.2.1.4 Student perspectives

Analogies are important language tools that enable students to share concepts and bridge understanding with others. The student interviews provided additional insights into students' emergent activity, including sharing concepts, knowledge, ideas and interactions with tools that enabled their dialogic activity. In terms of sharing knowledge, one student explained that sharing information "solidified information in your own mind if you're giving advice, helping people figure things out, you can see it better yourself." This showed that sharing knowledge, in this instance, was a reflective act. Interestingly, another participant explained that often the students would call or text each other questions or information if they failed to understand a problem or course information. For other students in the cohort, sharing or seeking information was preferred through digital means. One student explained that he "wanted to extend [his] learning outside of Unitec and help with [his] language [learning]" when he used Google, YouTube, and Wikipedia. Another participant said that he followed Electrical Engineering YouTubers who made helpful explanatory videos. Sometimes, the application of the theoretical knowledge can be enriching for students. One student expanded on this point, saying "when I start the day [in the theory session] being really confused and like what? How does this work? And by the end I have a more comprehensive understanding of what's going on; so that's good, satisfying, super satisfying."

6.3 Schematics as Mediational Tools

6.3.1 On a schematic

Schematics act as instructional tools that enable dialogic activity. The following vignette highlights the importance of them as mediational tools.

6.3.1.1 Context

It is the middle of the term and students are working in the 3-phase area of Mataaho. The instructor handed out the schematics which the students were required to use for the day's practical session. Schematics are used to show the mapping or the wiring configuration of a control circuit. Students are required to learn how to use these representations in preparation for their future work in the field. The schematic shows the control and power circuit configurations which they are asked to wire in the practical session.

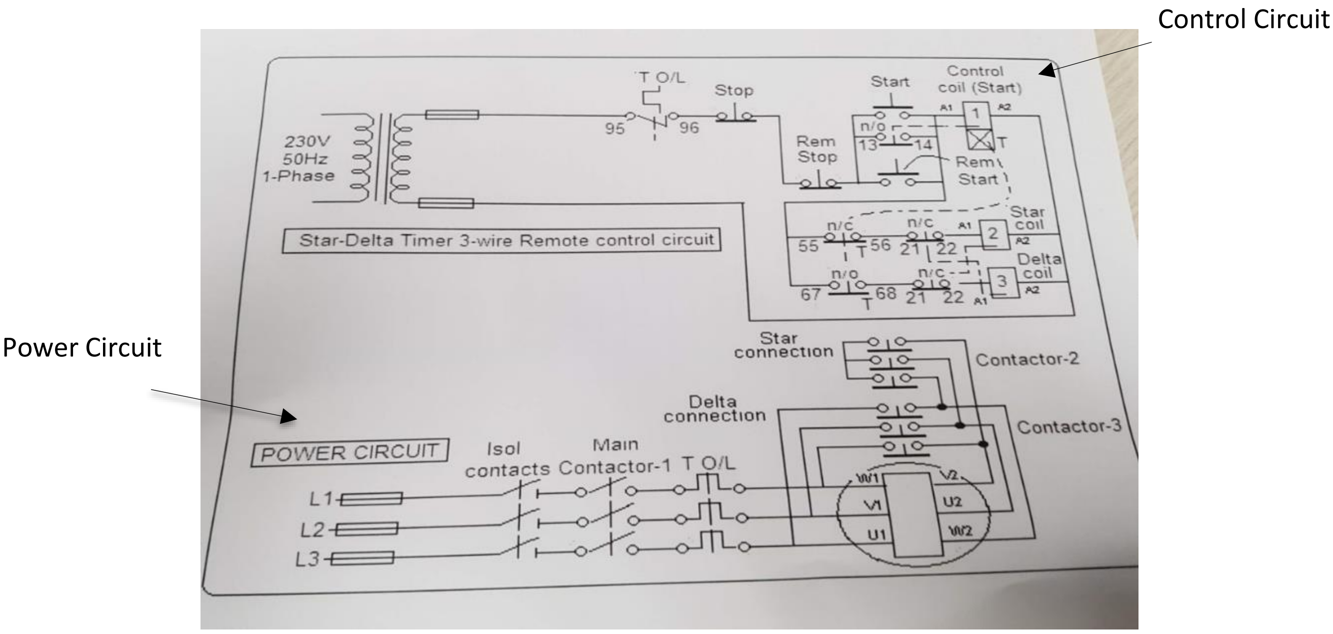


Figure 20. Star-Delta timer 3-wire remote control circuit highlighting circuits.

The students are expected to wire their boards in the following order: power circuit, control circuit, and motor. The schematic separates the layers out so the students can read how each one is to be configured. When they wire it to the board, one layer sits on top of the other.

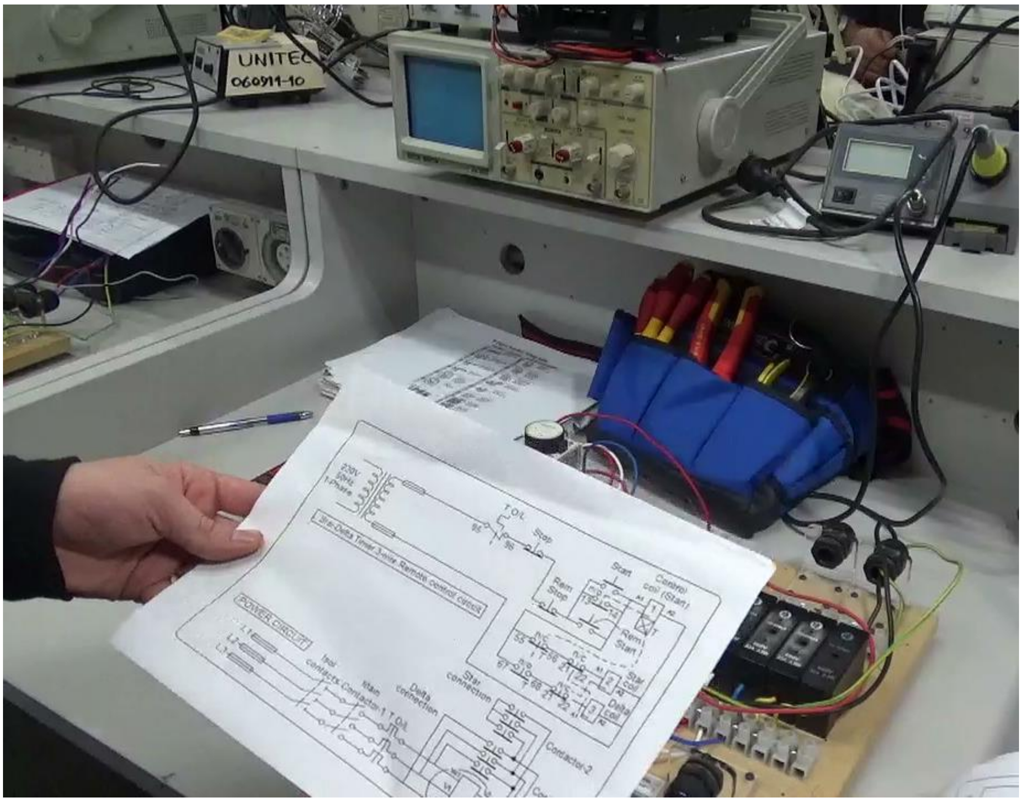


Figure 21. Student using a schematic.

6.3.1.2 The activity

Students are energetic and are actively engaged in the practical session. I observed a student double-checking his work against a schematic.

I asked:

1. Researcher: OK [Student 8] tell me what you're doing? You're looking at…
2. Student 8 holds up the schematic for the assignment in class.
3. Student 8: I'm reading the wiring sheet we've been given.
4. Student 14: We are doing our, firstly doing our power circuit.
5. Researcher: Yep.
6. Student 14: Cause that's how.
7. Researcher: The first one.

8. Student 8: Yes, this one, down here.
9. Students point to the schematic and the power circuit configuration at the bottom of the schematic.
10. Researcher: Yes, cause that's what [the instructor] talked about in the theory.
11. Student 14: Cause mainly any time we have a power circuit and a control circuit we always have to start with the power.
12. Researcher: Power.
13. In agreement Student 8 answers.
14. Student 8: Power.
15. Researcher: Yeah, because I remember the first time, he did it he did the control circuit, and it was confusing. Yeah, that's cool. So how are you finding the schematics? Are they helping you?
16. Student 8: Yeah, yeah, they're pretty good.

6.3.1.3 Analysis

While this vignette did not reflect a specific conjunctural event, it is possible to notice entanglement through relationships between the artefacts (T) and the students (H) and their dependencies (TH, HT). That is, the student depended upon the schematic (T) as a dialogic tool to correct interpretation. He followed the flow of the wires in the diagram and emulated them on the board (T) via his activity. It was a process of translating the written instructions into the physical activity of wiring the board at the appropriate locations, called terminals. The wiring board did not provide the terminal numbers to connect the wires to, whereas the schematic did. While this may seem to be a simplistic conversation, Student 8's reflection questionnaire reiterated the importance of understanding and reading the schematic to his work. In his self-reflection questionnaire, the student said, "I need to work on reading the sch[e]matics." He also stated that talking helped to further his knowledge mostly when he did not understand something as it "cements his knowledge better." In the dialogic act, if he did not understand something, he inquired and shared information with others to consolidate and improve his understandings.

6.3.1.4 Student perspectives

Understanding and interpreting schematics is an important skill for Electrical Engineering apprentices. Schematics play a part as a psychological tool or knowledge tool because they create inner dialogues that enable students to interpret them into dialogic activity. Interestingly, students used other dialogic tools, such as digital photos that they shared in their Facebook groups to solve problems. One student explained that "instead of explaining all in [a] text, we just take a picture of it. How did we solve this question? Like that."

Alongside schematics, sharing course content and answering questions happened in different ways. Three of the four participants in the student interviews said that they would seek knowledge or information from their lecturer or peers if they had questions about their course content, whereas the additional student showed a preference for information conveyed via Google over the provided content by the LMS. In addition, two of the students said they would share information through Facebook messenger, with photos of wiring boards or to assist with problems. One of these students explained this by saying that "the picture is more about explaining the concepts that were the questions we were all struggling with." The dialogic space extended into the digital space, one in which a picture became a pictorial representation of a solution. For this cohort, images of students' work became dialogic tools as points of shared knowledge, inquiry, and reflection.

6.4 Mathematics as a Mediational Tool

6.4.1 On units of measure

The following vignette provides an example of a learning entanglement that involved performing mathematics.

6.4.1.1 Context

The term was ending, and the theory sessions have now become review sessions for the capstone examination. The capstone examination is an external exam that students must pass to be eligible for electrical apprenticeships. The energy in the sessions was at a low ebb, students were tired and somewhat anxious as the end was in sight—finishing their course after a year of study. This activity was the last one required for their workbooks: how to calculate the efficiency of an electric motor. The instructor set the stage for the final activity by providing some instruction in the morning theory session and asked students to go to the course Moodle page to access the quick response (QR) code activity for the practical session.

6.4.1.2 The activity

Students were asked to wire and configure a 3-phase motor with an eddy current drive. Once this was completed, they were tasked with taking measurements to calculate its efficiency. A QR code, or quick response reference code, is an electronic code that can be recognised by a camera with the correct application on it, in this case a smart phone; the device takes a photo and based on the code it directs the user, in this case, to a YouTube video which demonstrated the activity for the day (see Figure 21).

Figure 22. QR code motor efficiency task.

To calculate the motor efficiency, students were tasked with taking measurements of the power input and output of the motor.

A worksheet was provided to guide students through the steps in calculating the amount of force generated by the engine. An eddy current drive acts as a clutch for the motor and, as the load or power is increased on the eddy drive, the load on the motor can be increased. The clutch and the motor impact the amount of electricity output since there are inefficiencies such as heat and friction that may impact the efficiency of a motor. The QR code was used for students to access the online instructional video for the task. Students were working in the practical session in self-selected pairs. The pair I observed had just finished wiring, measuring and successfully running the motor and Student 5 was working on the calculations on the worksheet (see Figure 23).

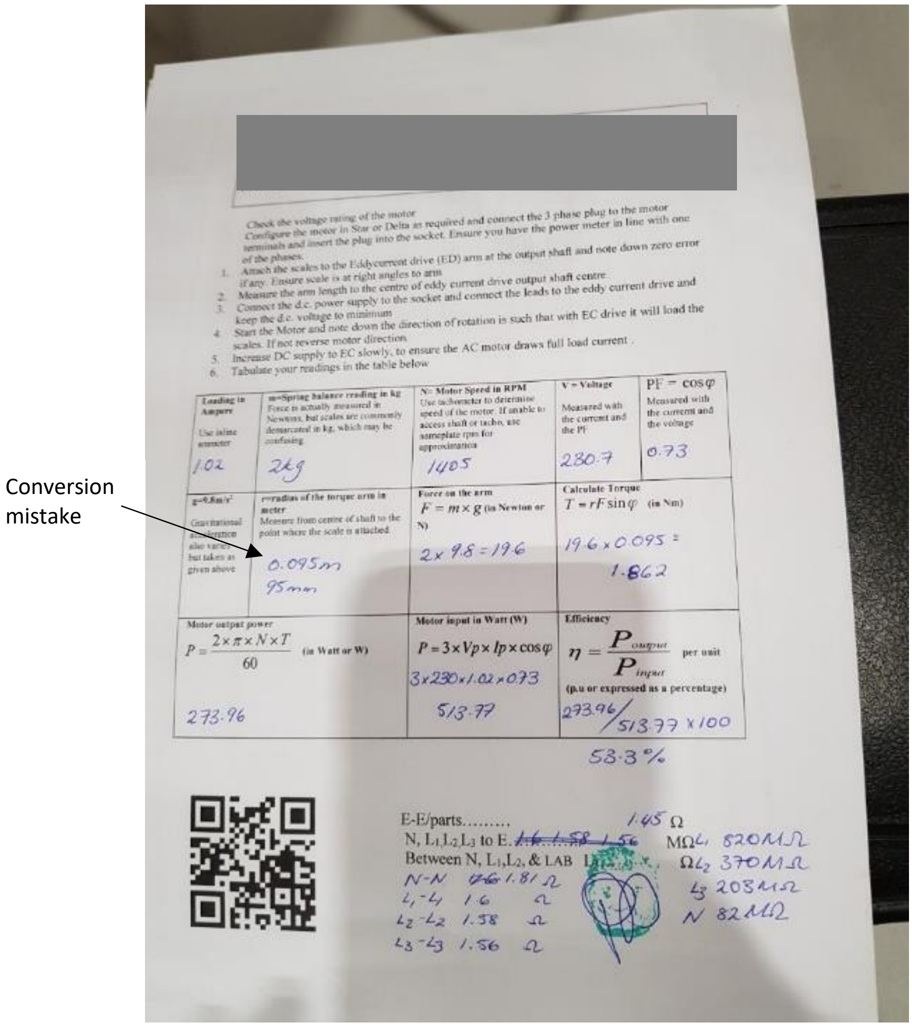


Figure 23. Student calculations including conversion mistake.

After multiple attempts, the students, realising that their calculations were not adding up, were becoming frustrated and agitated. Student 5 called the instructor over for assistance.

The following discussion occurred:

1. The instructor points to the worksheet and a number.
2. Instructor: OK that’s what I’d expect. Your spring balance which needs a 2 KGs along with these probably starts at about. Is that on zero?
3. While talking, the instructor touches the machine and looks at the lever to check the amount of pull (weight) that indicates the KG load on the lever. Both students were watching and listening to the instructor as he did this.
4. Student 5: No.
5. Instructor: And then pull down to there.
6. The instructor pulls the lever down.
7. Student 5: No, that’s exactly on the 2.
8. The scale is displaying 2 KGs.
9. Instructor: OK. Cool.
10. The instructor returns to the worksheet on the bench.
11. Instructor: And then you got the speed from the name plate on the motor.
12. Student 5: Yeah.
13. Instructor: Nice. And you got your voltage. You got your power factor. Looking good. And you got, what’s this one here? The radius 9.5, you converted that to metres. Why did you do that?
14. The student responds and speaks while using the calculator to recalculate the numbers.
15. Student 5: Well 9.5, well 95 millimetres.
16. Instructor: Well 95 millimetres as well, right? .0 9 5.
17. The student smiles while looking the figures on the worksheet, realising she made a mistake, then volunteers the following in a very quiet, sheepish tone.
18. Student 5: I like millimetres too.

19. Instructor: Can you write that down; I've done it once in meters as well too. It's kind of like getting my head around it.
20. Student 5: I was just writing what people were…
21. Student 5 chuckles.
22. Student 5: Saying.
23. Instructor: Yeah. And what did you do here? You went force is mass times gravity. OK your gravity times 2000. Where did you get your 2000 from?
24. Student 5: Maths.
25. Student points her pen to her writing on the worksheet.
26. Instructor: Maths. That's in KGs.
27. The instructor points to the next number on her worksheet.
28. Student 5: Oh OK. So that's 19.6.
29. Instructor: OK so you get your 19.6 over there.
30. Instructor points to another part of the worksheet. The student smiles and says the following.
31. Student 5: And that would be basically explaining everything.
32. Instructor: Cool. 2 KG. So, you got 2 KGs that's about 20 Newtons. That sounds about right. Yeah?
33. Student 5: Yeah.
34. Instructor: Cool. Try that. Excellent.
35. Instructor walks away. Student 5 recalculates her worksheet. And speaks aloud to herself as she punches the numbers into her calculator and writes down the figures.
36. Student: 19.6 times…. Man, this is….
37. She stops speaking to herself and finishes the calculations. She turns to speak to the researcher.

38. Student 5: So, I did a silly non-rounding. Yeah.

39. Researcher: Silly non rounded KG?

40. Student 5: So, I rounded from KGs to grams when I should have stayed in KGs.

41. Researcher: Ok. Ok. That's OK, so now you know.

The units of measure threw off the calculations. The student was relieved to have resolved the error.

6.4.1.3 Analysis

After a prolonged period to get the motor successfully started and measured, the completion of the worksheet was the last hurdle towards finishing the activity. The conjunctural event of the incorrect answer, caused the students (H) to seek additional information from the instructor (H) and this was mediated by the mathematical language on the worksheet (T). The question-and-answer sequence showed how the instructor guided the student to the solution by asking for justification with each step.

The act of requesting instructor assistance enabled the students to query and understand (or to know) why they had arrived at the incorrect calculation. In addition, the close proximity of the students in the work space enabled Student 5 to overhear others claim the answer as "9.5" and she chose to use it in her calculation instead. That is, her proximity to others impacted her answer. She participated in someone else's sharing of knowledge when she listened to dialogues about the *correct* answer and did not question its veracity. It is an example of how shared understandings can be true, false or, in this case, mis-interpreted. The instructor scaffolded the student's dialogue through each step of the formula, and it was evidenced by her repeating after him or answering his questions at each point throughout her exchange with the instructor (lines 1-35). That is, she checked her understanding against his queries and encouraging statements along with the numbers on the worksheet in a series of cumulative and reflective acts. This process shifted her understanding to the correct solution when she explained, "and that would be basically explaining everything." At the end of the session, Student 5 wrote in her self-reflection for the day that she had improved by "thinking about class and how things work" showing that her experience with the calculations impacted her reflection. That is, her activity (performing calculations) gave rise to other activity (written reflection) in combination with internal (reflection) and external dialogue with the instructor (solving the calculation).

6.4.1.4 Student perspectives

Learning to evaluate information or shared knowledge is an important part of students' learning. Presenting information or sharing it in different ways can be helpful to students—or misunderstood—and forms a part of students' dialogic activity. One student confirmed this idea by saying if the teacher is busy "then maybe I can give them information in a different way, that means they can follow it." In addition, working together in collaboration and sometimes in fun competition with each other was equally important for the students. One student said, "It's just like trying to help each other out. Cause we're all trying to pass the course. It's not like competitive or anything. We have that sort of friendly-like competitiveness; it's just between us…but that doesn't mean we don't want to help each other out."

6.5 Findings Summary

Dialogic activity was presented throughout Case Two. It emerged in the form of students' sharing knowledge, inquiry and reflections. For some students, sharing knowledge took place in different forms. This included texting, or using a Facebook group, or as one student pointed out, they would simply call each other on the phone to check. As he explained: "we had some chats more to do with assignments. If we were stuck on an assignment, we'd give each other a call or text."

Aside from sharing information, students shared their tools with each other, both digital and physical. For them, unanimously, the most important tools were multimeters and insulation testers to help them perform their work. A multimeter is a multi-function unit which enables students to measure voltage, currents, and resistance. An insulation tester is used to ensure electrical devices, parts and equipment are protected (not faulty) from electrical shock. These two tools enable students to perform the necessary safety tests of their equipment as they wired their boards. As noted in the previous section, the importance and significance of these health and safety tests were also stressed by the instructor. Notably, it was observed in the face-to-face sessions that students willingly and regularly shared these tools that were central to their work.

In terms of digital tools, it was unanimous that students used Google for obtaining information about the course's content. In addition, one student explained that he used his Facebook group as a way to get or share information in his course: "If one of us got stuck on a question or even just something in class you just send everyone a message and it's about 15 of us so you'd usually get an answer from someone or either the correct formula or just tell them come have a word with me on Monday we'll figure it out, type of thing." In this case, the digital space in which this student participated expanded to over half his class size. It was observed that students regularly crossed into their digital dialogic spaces as they hovered around their boards in dialogic activity.

In relation to the physical learning spaces within Mataaho, the student responses were mixed. Noise featured as an issue during their first semester because the students worked near the plumbing students who generated lots of noise. One student noted the noise was so loud: "…to the point where most of us wore ear plugs during class so you couldn't hear." However, during the second semester noise proved to be an improved experience for the student participants. This evidence signals that the quality of an open learning space may impact students' learning entanglements.

6.6 Conclusion

The learning entanglement and situations that emerged within the Electrical Engineering cohort showed that language and digital and physical materials are melded together within dialogic activity. Although, the course design was relatively new, the instructor adapted it for the students' needs when required and included multiple opportunities for shared knowledge, shared inquiry, and reflection and dialogic activity. In addition, health and safety requirements were purpose-built into all aspects of the course design. Dialogic activity was also present and part of learning situations and entanglements. The case showed that dialogic activity emerged in the form of an analogy, from using schematics, and presented mathematics as a mediational tool.

In the next chapter, the third case, Mechanical Engineering, is presented.

7 Case Three–Dialogic Activity in a Mechanical Engineering Tertiary Learning Environment

The third case study for this research is the Mechanical Engineering Level 3 course. This course was designed for students who were working towards qualifying as apprentice welders, apprentice fabricators, or apprentice mechanical engineers. In this chapter, I explore the importance of course design and planning, how supporting technologies may, at times, be disruptive and the role of problem solving and spaces in learning entanglements. Reflections of four students, who were involved in the critical episodes described in the vignettes, are also discussed.

First, I discuss the findings from the instructor interview which yields insights into the course design.

7.1 Design of the Mechanical Engineering Course

The Level 3 Mechanical Engineering course was unique in this study in that three instructors co-taught the course. Two of these instructors taught theoretical and practical sessions and the third taught welding (being a master welder). The three instructors described the course as involving BL and project-based design (epistemic design). Learning tasks were designed to offer opportunities for "problem solving…in a scaffolded way starting [with a] simple project and working into more complex [ones]." One instructor noted that the theory "related to what they're doing in the practical part of the course" (epistemic design). All the course tasks were preceded by health and safety reviews (epistemic design).

Learning tasks (epistemic design) were designed to provide opportunities for students to share information and knowledge. One instructor pointed out that Fusion 360 and the Hapara Learning Management System (Hapara LMS) (set design) supported students learning activity by providing opportunities to share ideas and to collaborate. Fusion 360 contains multiple modules (epistemic design) to scaffold students to co-create (emergent activity) using software applications such as computer aided design (CAD), computer aided manufacturing (CAM) and computer aided engineering (CAE) (set design), all in one, cloud-based software package. The students were assigned individual components of a project, which, when assembled and manufactured, formed the entire project. Importantly, students worked together (social design) to co-design and develop projects (emergent activity) using this software package (set design) and well-crafted learning tasks (epistemic design). Fusion 360 is an industry wide accepted tool and knowledge of its use is important to become a member of Mechanical Engineering communities. In addition, students shared knowledge through their workshop activities and practical exercises (emergent activity), with one instructor noting that "they look at [their projects] and they try and teach themselves" and in this process they shared information with each other. Another instructor noted that "sometimes it took a bit of effort to get them involved in collaboration, even when they used Fusion 360 which 'forced' collaboration both digitally and in person" (epistemic, social and set design, and emergent activity).

Shared tasks were included as part of the course projects (epistemic and social design). One instructor noted as the semester progressed, students would spread out, with some being faster than others and said "that [the students] might make mistakes and then, hopefully, allow the slower people to not make mistakes." This meant that students progressing at different speeds provided opportunities from them all to learn from each other (social design impacting on emergent activity). All three instructors agreed that the nature of the project designs also provided many opportunities for shared incidental learning, even though there was only one required team project: the rocket stove, which was a camping stove that students co-designed in groups and manufactured with steel.

As to opportunities for shared inquiry, it was evident that artefacts at times mediated students' learning conversations. One instructor noted that there was only one manual mill, which meant students had to queue and take turns to use it. "So [while] somebody's doing that, the others are watching and talking about their [the student using the mill's] stuff." That is, the students discussed their work based on their observations of a peer. For the welding projects, most of the students analysed and queried their work after completion. Students began by learning how to weld on virtual welding machines and then progressed to the physical, real, welding machines. The instructor described opportunities for shared inquiry, once they finished their initial real welds, as the point "when their questions arise. Something's not going right." He noted that is "the difference between the virtual and real weld. Students get to set up their own [physical] machines. With the virtual [machine], the machine is pre-set" already. With the Metal Inert Gas (MIG) welding machines, students were responsible for the set up and configuration of them.

Opportunities for self-reflection were included in the course design (epistemic and set design) and emerged (emergent activity) as students progressed through their tasks. One instructor described a technique in which the students get "an A3 sheet of paper divide it into four and the very bottom left corner is [used] purely for self-reflection—getting students to think about, for instance, if I had to do it again, what would I do that's different." The other three quarters of the A3 sheet of paper included space for sketching the project including safety concerns, new terms with descriptions, and the manufacturing processes involved in the students projects. I observed that these sheets of paper were used by students for every project in class. In addition, another instructor asked students to spend 5 to 10 minutes at the end of each project to write down their reflections and then upload them to the Hapara LMS.

In welding, a welding joint is formed when two or more pieces of steel are welded together. Joint welding, such as butt joints, t-joints and collar joints, required students to reflect about their welding angles, speed and different features of the metals involved in the welds. The instructor noted that he overheard a conversation between a student and another instructor, and that the student said he was "really getting into the self-reflection and reading his [self-reflective] work [seemed] to be helping him." It was interesting to observe how a material artefact (A3 sheet with a particular space for their notes) (set and epistemic design) supported and scaffolded students' reflections.

Relative to improving the course, the responses from the instructors were mixed. One instructor felt the breakout rooms were challenging but that the main concerns were the noise and ambience in Mataaho. Another instructor believed that some assessments needed re-design. The third instructor pointed out that opportunities for other types of welding such as arc welding, tungsten inert gas (TIG) welding as well as using the plasma cutter (cutting metal with a jet of ionised gas at super high temperatures), were important for students since they needed these skills in the workplace. Furthermore, in different ways the instructors felt the course was successful. One instructor felt that success was measured by job offers or if students pursued further education in their field. Another instructor felt that it was measured by successful project completion and the third instructor emphasised that overall, the "students [were] becoming more independent [and] starting to be engineers, which [was] good."

The first vignette for this case study further discusses the importance of planning a practical weld task, in ways that encourage shared and self-reflective processes.

7.2 Planning as Dialogic Activity

7.2.1 On planning

The following vignette highlights the importance of planning as dialogic activity.

7.2.1.1 Context

It is the second week of the second semester and after waiting an entire term, the students are keen to enter the welding bay and manufacture their projects. The students participated in the welding theory sessions in the previous week and are now planning and welding their projects. In the day's session, the safety briefing had been conducted, and the instructor took time with Students 10 and

11 to strategize their welds using a jig to manufacture them. A jig holds the metal pieces into place as the welds are applied. In this case, the jig is shaped in a way that allows students to place a metal plate on top of it and lean the tabs on the sides (see Figure 24). Students were tasked with welding the metal tabs to a plate using tack welds for their trailer mover project. A tack weld, also called a spot weld, holds the pieces of metal together with a coin-sized weld, not one long, continuous weld.

Figure 24. Planning spot or tack welds with tabs.

7.2.1.2 The activity

Students 10 and 11 are planning their welds with the instructor and are watching and listening to the instructor at his workbench in the welding bay. The instructor and students are planning their welds using the jig. The students are watching the instructor place the pieces on the jig.

The follow dialogue occurred:

1. Student 11: I think you're meant to weld it.
2. Student 11 points the location on the pieces where the first weld is meant to be placed.
3. Student 10: Oh, I see!

4. Student 10 stated this emphatically.
5. Student 11: I think you just go underneath it like that.
6. Student 11 holds a steel tab in place on the piece of metal to show the location of where the weld is meant to go.
7. Instructor: You just go… you set it on top.
8. The instructor places the top plate on top of the jig.
9. Student 10: And take it to the corner…
10. Student 10 is describing where he thinks the exact placement of the top plate on the jig is meant to be.
11. Instructor: And take it to the corner.
12. The instructor places the tab on the jig.
13. Instructor: It sits there.
14. The instructor places the tab carefully on the jig in the location where it is meant to be welded.
15. Instructor: And it sits there.
16. Moving the tab into the correct position.
17. Student 10: Oh, I see so you just….
18. Student 10 points to the location on the jig where the spot weld will go.
19. Instructor: Yeah, and then we just…. The jig is here for tacking.
20. Student 10: Yep.
21. While Student 11 nods simultaneously.
22. Instructor: We make this jig this ah ….
23. Student 10: Just to hold it in place.
24. Instructor: Just to hold it in place for then you can tack, tack. And then that is where you weld and that is the right place for them here.

25. The instructor holds the tabs on top of the jig while using his fingertips to point out where the tack welds should go. Student 11 nods in agreement.

7.2.1.3 Analysis

Apprentice mechanical engineers are expected to use jigs in the workplace. Self-reflection and planning are important when dealing with material assemblages, allowing students to make connections between their thoughts, the world to be perceived, and their activity. The artefacts, the welding jig and metal tabs, played a central role in the learning dialogue for this vignette. As the instructor physically positioned the metal tabs on the jig, he discussed with students the step-by-step process of how to use the metal components, sharing knowledge about the assembly of the jig. As this occurred, the students were able to see, touch and interact with the artefacts while simultaneously verbalising their questions, knowledge and reflections about this process.

Student 11 commenced this dialogue by showing Student 10 where he thought the first weld was meant to be placed. Student 10 acknowledged this point by stating “Oh I see,” as he watched Student 10’s placement of the tabs very carefully. The utterance suggested that he was carefully observing this act, offering a verbal form of self-reflection. It also provided an example of talk in which the speakers could acknowledge and build upon each other’s knowledge. This differentiated itself from repetition because the students were visibly moving their hands and touching the plates, making their thinking visible, as they planned and discussed their welds with the jig. As the instructor manoeuvred the pieces of metal over the jig, Student 10 verbally confirmed the instructor’s steps as the instructor repeated Student 10’s statements (lines 9-11). For example, Student 10 stated, “Just hold it into place,” and the instructor mirrored this statement by immediately repeating “Just hold it into place” (lines 23-24) and elaborating and pointing “for then you can tack, tack.”

In the daily written reflection, Student 10 noted that he asked questions but that it was too early in the week to tell how he could improve. Student 11, on the other hand, wrote that he learned how to hold the jig in place, but noted that he needed to improve his measurements for his components as he was "always a few mils [millimetres] off." Student 11 also pointed out that he shared his knowledge verbally and participated in shared inquiry by asking questions about the activities in the day's session.

7.2.1.4 Student perspectives

For this cohort, opportunities for sharing knowledge and information were present throughout their course. Students sought and shared information in many ways. For three of the four research participants, this represented a process which began with the instructor. If the instructor was unavailable, students proceeded to their peers or to digital modalities such as Google and YouTube to access information. The fourth research participant chose to seek information from the Hapara LMS prior to seeking input from his peers. This student also noted that if those options did not work, he'd "go to a group chat…for the class, then start asking around the guys [in class]." One student noted that the instructor "wouldn't usually give me the answer, but he'd tell me how to find it. Or he'd give me the answer without giving me the answer." That is, the instructor would challenge the student with questions or other points of information to consider without providing the specific answer. Another participant said that he would allow other students to look at his notes and sometimes his peers would point out if something was wrong. This allowed this student to double check his written information and understanding with his peers—a reflective act. Another student said he preferred the stories from one of the instructors in the theory sessions. In sum, students were actively using a range of strategies, as well as multiple material and digital artefacts to support their learning and dialogic activity.

The next vignette investigates the support that technologies provide and how they contribute to enabling students to complete their work.

7.3 The Role of Support Technology

7.3.1 On disruptive support technology

7.3.1.1 Context

The Mechanical Engineering students are meeting in a small breakout room in Mataaho, 333-1048. The room accommodates up to 20 students and is set up in a traditional classroom style with rows of desks facing the front of the room that has a whiteboard and markers. It contains felt panelling on the walls which has the effect of softening sound in the room, making it a pleasant location for small-group discussions and work. The students are working on calculations in Fusion 360, a 3-D componentry modelling program, for the pieces of metal they will manufacture for their final group project, the trailer mover. Fusion 360 is an online 3-D modelling program that enables students to create 3-D and 2-D drawings. It allows collaborative authorship as well as the creation of components that assemble into a project. Students can work on their designated component(s) simultaneously and store it/them into a team folder to make group assemblages from their drawings. When the instructor announced that there were only 21 more face-to-face session days left in the term for instructor assistance and urged students to keep working industriously on their projects, the students became keenly focussed on their activities.

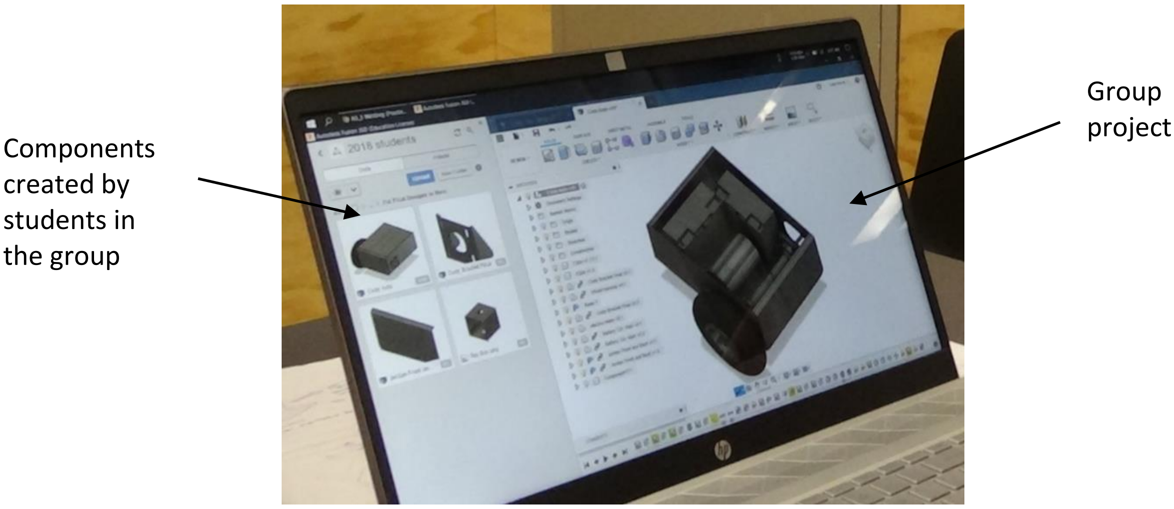


Figure 25. Example of a group project in Fusion 360.

7.3.1.2 The activity

The students were sitting in self-selected pairs within their group configurations. Students 11 and 12 were checking the specifications for a previous project against their measurements for a component designed in Fusion 360. By way of context, during the previous night a thunderstorm in the area had sparked an internet outage.

The following conversation occurred:

1. Student 11: I think your computer might be more fast than mine. We might do Fusion on yours. Because I think, I swear I think the Mosrove is faster than this computer.
2. [Mosrove is the name for Student 12's laptop computer.]
3. Student 12: Was your wi-fi working last night?
4. Student 11: What? in my house?
5. Student 12: Yo.
6. Student 11: Na, I had to restart it.
7. Student 12: My one wasn't working.
8. Student 11: Yeah, I had to restart it.
9. Student 12: I think it will be an early night for me tonight.
10. Student 12 is implying he was up late the night before trying to get work done.
11. Student 11: Yeah, I was probably gonna turn it off anyway. It was like 2:30 AM when I turned it off.
12. Student 12: I still was trying to do it eh. Like every time it goes on, it goes off.
13. Student 11: Did you restart the program?
14. Student 12: Yeah, I restarted it…how many times? My mum was getting angry.

7.3.1.3 Analysis

While the students used Fusion 360 to check their calculations and measurements, they spontaneously turned the dialogue to how the lack of wi-fi disrupted their homework. That is, they spoke of the way in which a thunderstorm (conjunctural event) impacted their internet access (T) affecting the learning entanglement and resulting in students' non-completion of work. Since the wi-fi connection (T) was periodic the night before, the students (H) were unable to reach into the space of Fusion 360 (T) to work on their collaborative projects. Hodder's (2012) conceptualisations of dependence and dependency between humans and things allow us to see a chain of actions and reactions as students depended upon their access to wi-fi for use of their internet-based software program, in this case Fusion 360. Student 12 had to reboot his modem multiple times which impacted his family's wi-fi access. This dependency between humans and things influenced the completion of the task. The unpredicted event created a technological disruption that prevented work for both students. Through a series of shared questions and clarifications, Student 11 and Student 12 revealed that the wi-fi outage was not a singular experience and that it was mutually frustrating. The dialogue also revealed that the students were up late attempting to work on their projects, with minimal success. Later in the reflections for the day, Student 11 noted that he learned more on the day in class about Fusion 360 and that he wanted to learn even more about it for further improvement. Student 12 reflected that he needed to open up more about his ideas and share more with others in the class. For Student 11, it seemed that his work with the digital artefact, Fusion 360, featured highly for the day. Course work tends to build around a tacit assumption that students experience uninterrupted, continuous access to their digital tools at home, including wi-fi. The thunderstorm event caused a disruption, revealing that the learning entanglement here also included students' dependency on access to technology and Fusion 360 at home.

7.3.1.4 Student perspectives

The sudden interruption of the support technology (wi-fi access), support skills (like mathematics) or student behaviours, make evident the existence of dependencies between things and humans in the learning entanglement. The students' preferences for most and least favoured activities in the face-to-face sessions provided insights into the qualities or properties of the materials required for their material assemblages. For two of the students their least favoured activity in the face-to-face learning environment included mathematics (HT). For another student filing the pieces of steel was repetitive, but necessary so the metal pieces were not sharp and could be handled without cutting (HT). Another student found that reliance on peers for their group assessment frustrating because in his team, the group members did not contribute to the project (HH). Humans were dependent upon humans to fulfil their learning expectations, but they were not fulfilled. In terms of most favoured activities, three of the students preferred fabricating or welding, whereas one student found listening to one of the instructors' stories and insights his most favoured activity.

7.4 Problem Solving as Dialogic Activity

7.4.1 On problem solving

7.4.1.1 Context

It is the last observed session for the term and the Mechanical Engineering students are working on their final team project called the trailer mover (see Figure 26) in the breakout room, 333-1048. Students are highly focussed, knowing that their team projects are due soon. The room is littered with pieces of metal and components that are partially assembled. It is early in the morning and the team members are beginning their work on their final projects—the trailer movers. The trailer mover is a battery-operated machine that helps move trailers for example, boat trailers and camper trailers (without the use of a car). The students are responsible for sketching and planning the specifications for this project in Fusion 360 and then for manufacturing the components. While the physical space of 333-1048 is not built for working on projects, students moved desks together, when needed, to work on their components. The trailer mover uses a chain wheel and a chain to power or move the wheels, much like a chain and chain wheel are used to move the tyres on a bicycle or motorcycle (see Figure 27).

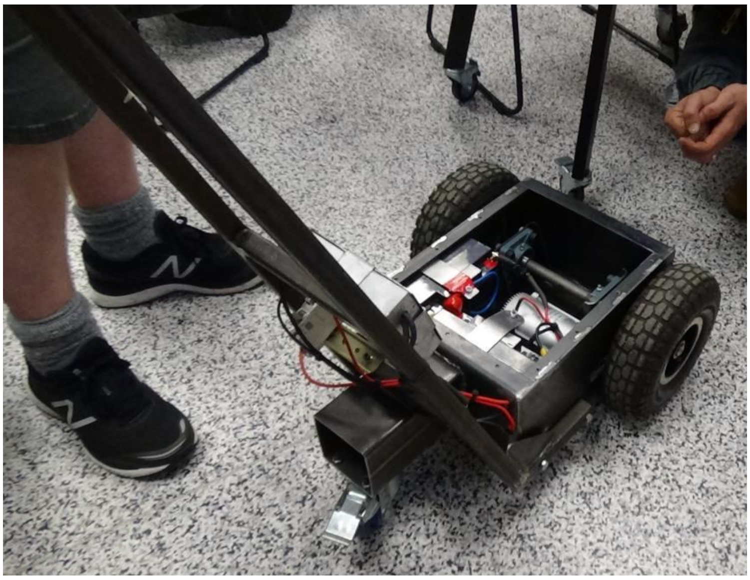


Figure 26. Inside of a trailer mover.

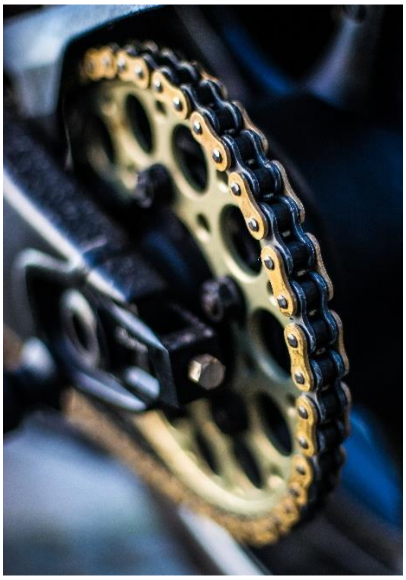


Figure 27. Example chain wheel (Photo by Conor Luddy on Unsplash).

7.4.1.2 The activity

Students 10 and 11 were measuring and analysing the spaces between the holes in the metal box that the chain and chain wheel will be anchored for assembly. Student 11 realised that the bottom plate of the box did not have the manufactured holes in the correct position for the chain wheel assembly to be affixed. Student 11 was re-measuring the holes as Student 10 was observing the work he had done inside the metal box and Student 11 starts explaining.

The following conversation occurred:

1. Student 11: I put my [holes] slots out too far. It’s supposed to…put it up right over these things. So, I messed it up.

2. As Student 11 speaks he points to the holes in the trailer mover box and then points to where they're meant to be.
3. Student 10: Oh, so you gotta turn it over.
4. Student 10 mimics this movement to Student 11 with his gestures.
5. Student 11: Just about seven mil or just maybe after maybe…
6. Student 11 stops mid-sentence and turns to rummage through his backpack to pull out his ruler and starts measuring distances between the holes and the side of the metal box.
7. Student 10: I'm not sure mine is going to fit in. Maybe you can put them maybe 5 or 10 mil to the other side?
8. Student 10 continues to look at Student 11's work.
9. Researcher: So, what do you have to redo?
10. Student 11: I have put the slots too far this way. I've got to get them over here.
11. He gestures and points to the new location.
12. Researcher: Yeah, well that's alright that's not going to be too bad. So, what will you do that with?
13. Student 11: I'll probably chuck that in the mill. And we'll cut a plate about so big on the plasma cutter which will cover all of these bad holes and then we'll cut all the new holes.
14. Student 11 demonstrates the size of the plate that will be manufactured to cover up the other holes as his hands are placed over the holes indicating the size of the plate to be added and where the new holes will be placed. [A mill is a tool used to drill holes or slots.]
15. Researcher: So, what you're doing is creating a band aid.
16. Student 11: Yep. Pretty much. Yep, a trailer mover make-up.

The students carry on with their work.

Figure 28. Planning the fabrication of new holes.

Figure 29. Student 11 taking measurements with Student 10 observing.

7.4.1.3 Analysis

Although the students were assigned to different project groups, they came together to solve Student 11's dilemma, in a learning entanglement. Student 11 did not create enough space for the chain wheel to be affixed correctly (conjunctural event) within the metal box (T) for the trailer mover componentry to fit (T), including enough space for hands to attach them together (H). In this learning entanglement, Student 11 described to Student 10 the problem as the holes he manufactured were in the wrong position. The solution for Student 11 was aided by using the ruler (T) to take measurements. The solution also included Student 10's participation in the learning dialogue with Student 11 because, as he gestured, he asked a question (line 7) and provided a suggestion in the process (line 3). Student 10 also indicated, by comparison, that the assemblage of his team project's work may not fit because the holes in the plate were similar to Student's 11 project (line 7).

This vignette highlighted many elements involved in a learning entanglement and the subtle dependencies between humans and things. In addition, it also illustrated the point that dialogic activity as an embodied experience through the handling of the artefacts and the gesturing as the students spoke, for example. It also showed that embodiment can occupy a shared reflective space with gestures and without utterance within the course of dialogic activity (lines 11 and 14).

Student 11 noted in his reflection for the day that he missed the bigger picture sometimes on "important things" with the trailer mover project. Student 10 commented that he needed to engage in more "team talk." The artefacts of the metal box, the ruler, the act of measurement, gesturing and the discussion of the problem, created verbal reflection, shared knowledge and shared inquiry in this learning entanglement, and these actions, taken together, resulted in a resolution. The utterances and demonstrations revealed how dialogic activity can be actively observed by others. This vignette provides evidence that things and humans are inherent parts of a learning entanglement, alongside their activity and learning dialogues, and that these elements, in turn, provide opportunities for other dialogues, such as asking further questions. It also shows how the physical learning space, and the configuration of the furniture in the breakout room influenced the dialogic space shared between the participants in the learning entanglement. This was evidenced by two students assigned to separate group projects coming together to help find a solution, and further demonstrated the collaborative nature of this cohort.

7.4.1.4 Student perspectives

Like the breakout room (307-1048, see Figure 5 in Chapter 4) learning space that the students from the above vignette participated in, additional learning spaces played a role in the students' learning experiences and dialogic activity for this cohort. The student responses were mixed regarding the learning spaces within Mataaho. The spaces used for this cohort of students included the breakout rooms (307-1048 and 307-1060), the workbenches (307-1032 and 307-1030) and the welding bay (307-1064, Figure 5, Chapter 4). One of the students pointed out how he enjoyed the spaces and the accessibility to the equipment as "he thoroughly enjoyed [using] them." Another student described the spaces as "some good, some bad." Another student said that the building was a "little bit flawed. The lighting is quite terrible especially if you have to focus on finer points." This student further noted that they used their smart phone torches, but also indicated that electronics were not allowed in the welding bay, implying it was difficult to see his work in that space and acknowledging the risk of burning out his smartphone or PC due to the high voltage required for the MIG welding machines.

In addition, another student pointed out that there were challenges in using the welding bay because it was in such high demand with other student cohorts and that he was forced to wait to complete his work, which he described as "frustrating." Positives from two students about working in the spaces within Mataaho included the welding bay and, for the other two students, the workshop benches. One student described the work benches as "it's just [a place] to try to do the project myself." The students' perspectives revealed that the learning spaces and material assemblages available to them influenced and mediated their social-material relationships.

7.5 Findings Summary

Opportunities for dialogic activity were present throughout this case. Interestingly, it was found that dialogic activity occurred through multiple learning situations. The act of planning a weld enabled students to build positively and uncritically upon others' knowledge in a scaffolded way through their learning dialogues with the instructor.

In addition, two of the four student participants cited fabricating and welding as their most preferred in-class activity. One of the students explained that welding is "a lot more difficult to do than a lot of people realise." The other two included interacting with the instructor and using the milling machine as their most preferred activity. Besides sharing knowledge and information, sharing of tools and equipment in class was also important for the students. All four student participants shared their equipment and tools with each other in class (HT, TH, HH). One student noted there were plenty of physical tools provided for the course apart from hammers or scribes (used to scratch text or numbers onto the metal plates) to use (TH, HT). Another student added that he liked to share his tools with others just because he simply "like[d] to help 'em [the other students] out" (HH).

In addition, students' least and most favoured activities in the online environments provided further insights into other dependencies between humans and things. For two of the students, the least favoured activities in online environment included writing the risk assessments. A risk assessment is a document required for every single project in which students identified health and safety risks and highlights existing dependencies for safety (between humans and things). This is often a critical task but became laborious, in their view, because there were so many risk assessments to be made. One of the other students did not prefer the cross-cultural communication assignment, an assignment in which students had to identify ways in which they worked with each other incorporating elements of mātauranga Māori (Māori knowledge). Yet upon entry to the workforce, students will need to be able to communicate and engage with others (HH) in culturally appropriate ways. The fourth student noted that he did not have any least favoured activities and added that he used Google, Wikipedia and the FB group with his peers in class (HT, TH). In terms of learning to use Fusion 360, one student commented: “Actually once I got to learn all the basics and I actually understood what I was doing – I actually had a lot of fun getting creative and going designing my own things [in Fusion 360]” (HT, TH). The other two students preferred using Google and using the Hapara LMS, noting that the Hapara LMS “was useful because he could access it from overseas” (HT, TH). The artefacts used in the material assemblages such as risk assessments, assignments in the LMS, along with other digital tools like Google, provided learning opportunities within a confluence composed of material and human assemblages. In terms of the physical learning spaces addressed in section 7.4.1.5, the responses about the learning environments were varied; sometimes lighting or ambient noise created issues for the students.

7.6 Conclusion

The Mechanical Engineering case was unique in that three instructors taught the course. The course design included theory and practical sessions and provided opportunities for students to engage within the material-rich environments by way of activity and learning dialogues. Dialogic activity occurred within the three vignettes by way of planning, disruptive support technology, and problem solving for the students. Overall, the students enjoyed engaging within this environment with a significant preference for welding fabrication. While overall the students enjoyed using the learning environments within Mataaho, the students’ responses about specific spaces within Mataaho were mixed.

In the next chapter, I discuss dialogic activity and the themes that emerged within the three cases.

8 A Discussion of Dialogic Activity Within Three Learning Environments

This chapter discusses the themes that arose from the findings of the three cases observed in this research. First, the nature, types, contexts, and components of emergent learning dialogues from within dialogic activity are discussed. This is followed by a discussion about the role of the artefacts and tools, flexible learning spaces, environmental conditions, and health and safety and how they impact dialogic activity. Finally, students' perspectives, socio-material aspects of their learning, BL course designs are all discussed, and the importance of class culture in dialogic activity is explained.

8.1 Dialogues

Learning dialogues are a tool used to communicate thoughts and ideas and can be used in different modalities and contexts. This study explored emergent learning dialogues, as bounded together with the materials that students engage with, and as part of their learning activity. These learning dialogues occupied a dialogic space and appeared in different forms and contexts. They included forms of dialogic activity, cumulative types of dialogues, schematics as mediational dialogic tools, mathematics as a language, communities of practice, networks, and as language genres (Bakhtin, 2010b; Brinkmann & Tanggaard, 2010; Chan, 2021; Dawes et al., 2004; de Freitas & Sinclair, 2014; Hyland, 2019; Littleton et al., 2005; Mitra, 2011; Vygotsky, 1997b; Wegerif, 2013). Each of these themes will be discussed in the following sections to explain the context, nature, and the types of learning dialogues that emerged from this study.

8.1.1 Dialogic activity: shared knowledge, shared inquiry and reflection

Learning dialogues were found to be prevalent throughout the cases in this research. As discussed previously, reflection, shared inquiry, and shared knowledge constitute the foundational basis for learning dialogues. Examples of these components were present throughout this research. First, I begin with reflection.

The instructors for the three courses expressed their value in students' reflections, and purposefully built opportunities for reflection into their course designs. Instructors saw the act of reflection as a critical skill for trades students and fundamental to their future participation in the respective trades communities (Schön, 1987, 2017). Reflective tasks were, therefore, included in all courses. For example, in Mechanical Engineering students were required to write a reflection for each of their projects. For the Electrical Engineering students, the lecturer allocated a 10-minute period at the beginning of the practical sessions to encourage student reflection. For the Automotive Engineering students, reflection opportunities were designed into the project or assessments tasks. The vignettes for each case also highlighted moments of reflection as intertwined with shared knowledge and shared inquiry in different forms: reflections were uttered, written, or took the form of an internal metacognitive process (Bakhtin, 2010a, 2010b; Wegerif, 2013). Often, reflection emerged as part of an embodied activity, within the dialogic spaces shared by the students, described in the "On problem solving" vignette (see Chapter 7) in which the students gestured and measured the holes and their placement in the base of the trailer mover housing. Reflection also emerged in simultaneity with shared knowledge and inquiry (Bakhtin, 2010a, 2010b; Wegerif, 2006).

In addition to reflection, examples of shared knowledge and shared inquiry emerged across the three cases covering a variety of content and contexts. For the Automotive Engineering case, students shared knowledge and inquiry during a burnt-out lightbulb event on a UniTrain board, or by a broken spark plug socket wrench incident, and by noting the importance of a torque wrench. For Electrical Engineering, shared knowledge and questioning were exhibited across several passages such as when using an analogy to describe electricity in the vignette "On flow"; in describing the importance of a schematic in "On a schematic"; or as part of a learning entanglement in "On units of measure." The Mechanical Engineering case provided evidence of shared knowledge and inquiry in passages where students were planning a weld in "On planning"; by discussing a wi-fi outage in "On disruptive support technology"; and in determining how to resolve the manufacture of a hole in the wrong position in “On problem solving.” Of importance, however, is the point that shared knowledge, shared inquiry and reflection, taken together, formed the foundational basis of the observed learning dialogues. These three transpired regardless of the learning spaces used and the types of materials employed or transformed within the learning activities. In all three cases within this research, dialogic activity occurred at the intersection of learning dialogues (forms or combinations of shared inquiry, knowledge and reflection) and activity in simultaneity. However, the way in which dialogic activity emerged was dependent upon a combination of factors—the social configuration of the students, the epistemic or task designs, and the learning spaces (both digital and physical). That is, the physical and the socially designed aspects of the course also influenced the emergent dialogic activity (Carvalho & Goodyear, 2014; Goodyear et al., 2021).

8.1.2 Dialogic spaces

Dialogic space describes the metacognitive activity as well as the digital, and physical spaces within which students’ learning dialogues unfold (Wegerif, 2013). The concept of dialogic space can be characterised as an internal and external process (Wegerif, 2013). In this research, there included evidence of both internal and external experiences within dialogic spaces and dialogic activity. The external dialogues were observed and video-taped in the observed sessions and the internal dialogues were captured by the reflection questionnaires and as utterances. The dialogic spaces occupied by students, both internally and externally, were observed as enmeshed within their activity *as humans* and throughout their actions *with things*, including their material properties. This view of dialogic spaces draws on Hutchins’ (2014) idea that language, or a learning dialogue, is a “cognitive process that…includes a shared world of objects and events” (p. 37) and on Wegerif’s (2013) realisation that dialogic space is an internal and external human experience. This notion of dialogic space allows for an understanding of dialogic activity in relation to designable components within a learning environment. It provides an explanation of how certain design elements contributed to students’ engagement and how their engagement differed based on specificities of the learning context, including the tasks, social arrangements and the materials involved in students' dialogic activity.

8.1.3 Cumulative dialogues

Cumulative dialogues were sometimes present in different learning contexts and scenarios across the three cases. Cumulative dialogues are those in which students scaffold each other's ideas and understandings, building "positively and uncritically on each other's knowledge," to guide students through their inquiries, solutions and planning (Kershner et al., 2020, p. 28). The cumulative dialogues identified in this research included those that dealt with problems or planning such as reflections about the torque wrench, how to solve a mathematical problem, or planning a tack weld with a jig and metal tabs. A vignette from the Automotive Engineering cohort (see Chapter 5) revealed that the cumulative dialogue could be reflective in nature such as shown in the "On a torque wrench" vignette. For the Electrical Engineering cohort, the vignette "On units of measure" showed that the instructor supported the student through her solution to her mathematical problem in a cumulative way. For Mechanical Engineering, such knowledge building was evidenced by a cumulative learning dialogue (Fisher, 1993; Kershner et al., 2020; Mercer, 1994, 1995; Wegerif & Scrimshaw, 1997) via consultation with peers and the instructor in planning a tack weld, as described in the "On planning" vignette.

Interestingly, the many cumulative dialogues or ways of accumulating shared knowledge in a supported and scaffolded way occurred spontaneously without explicit instructor intervention or modelling, such as the students' embodiment and shared utterances in the "On planning" vignette. Instructor intervention or modelling are considered foundational in dialogic education. Most research on dialogic education, however, has focussed on primary and secondary educational contexts (R. Alexander, 2001, 2020; Lefstein & Snell, 2013; Littleton et al., 2005; Mercer, 1994, 1995; Phillipson & Wegerif, 2020; Wegerif et al., 2005; Wegerif, Littleton, Dawes, Mercer, & Rowe, 2004;

Wegerif & Scrimshaw, 1997). In the observed sessions, students necessarily were present to learn the foundational skills for their trades, and most of the observed learning dialogues revolved around modelling and making engineering thinking visible for the students by the instructors, rather than the modelling of critical, yet supportive, types of talk or exploratory dialogues (Chan, 2020a, 2021; Kershner et al., 2020; Mercer, 1994, 1995). These vocational trades tertiary environments provided a significantly different research context from (and a counterpoint to) the primary and secondary school learning environments in which the unfolding of disputational, cumulative, and exploratory dialogues have been investigated.

8.1.4 Schematics

Schematics serve as dialogic tools and were omnipresent with the tertiary trades environment. Schematics, referred to as "psychological tools" by Vygotsky (1997b), enable students to compare their own work against their interpretations of the tasks and their embodied activity. In this research, the use of schematics was identified within visual artefacts or pictorial instructions on how to complete tasks as mediational means in student activity and were extensively employed in the face-to-face and digital environments. Learning how to read and interpret visuals were key skills required for trades apprenticeships within the cases studied and formed a part of the students' language genres for their particular trade (Bakhtin, 2010b). That is, learning how to interpret through their activity proved to be foundational for all three cases. Lemke (1998) noted that artefacts like schematics serve to "multiply meaning" because the combination of the schematics or artefacts with dialogues facilitate students' abilities to make meaning and to express ideas.

The Automotive Engineering cohort used their workbooks which combined pictorial examples and associated written instructions to facilitate interpretation of tasks, such as those noted in the "On the torque wrench" vignette (see Chapter 5). The Mechanical Engineering students were asked to sketch their designs manually or digitally using Fusion 360 software, alongside their written explanations. For the Electrical Engineering students, the reading and interpretation of schematics, as described in the "On a schematic" or "On flow" vignettes, acted as a communications tool, influencing students' thinking and doing, and their dialogic activity and engagement with the artefacts (Brinkmann & Tanggaard, 2010; Hyland, 2019; Schön, 2017). Schematics for these cases acted as psychological and physical tools to bridge students' thinking, interpretation and action (Vygotsky, 1962, 1997a).

8.1.5 Mathematics

The analysis revealed that materials provided by instructors and dialogues between students involved discussions about mathematics. Mathematics has often been described as the language of science (Mitra, 2011). Vygotsky (1997b) signalled its importance as a language by proposing that algebraic equations are used as "symbolic tools" (p. 85). Mathematics provides the mediational means for humans to enact, alter or change the properties of things or the things themselves to perform science (Azram, 2014; Pietrocola, 2008). In addition, mathematics forms a part of the materiality of assemblages that students create (de Freitas & Sinclair, 2014). Indeed, it was observed that a knowledge of mathematics was foundational to the three cases and that students' engagement with it emerged as a psychological mediational tool in student dialogic activity (Vygotsky, 1997a, 1997b). In Electrical Engineering, for example, a student performed a miscalculation based on decimal point placement in the vignette "On units of measure" (see Chapter 6), which had important consequences for the completion of the task. Moreover, mathematics proved to be challenging for a minority of the students; two of them from Mechanical Engineering noted that it was their least favoured activity. Interestingly, students in each of the three cases were required to utilise Ohm's law to determine either the voltage, electrical current, or resistance rates and applied them to specific electrical tasks for their individual trade. In short, understanding and using the language of mathematics, the language genre of mathematics, and performing mathematical calculations proved foundational to students' dialogic activity (Bakhtin, 2010b; Mitra, 2011; Pietrocola, 2008).

8.1.6 Communities of practice, networks, and language genres

Throughout my observations of each case, it was noted that there were opportunities for students to learn and engage within their trade's specific communities of practice, learning networks, and language genres (Bakhtin, 2010b; Carvalho & Goodyear, 2014; Lave & Wenger, 1991). For the Electrical Engineering students, reading and interpreting schematics was considered an essential skill, and represented ways of communicating ideas. Students from Automotive, Electrical and Mechanical Engineering participated within their cohort-specific communities by using digital tools such as Facebook messenger to send digital photos or to ask questions, sometimes calling upon their personal networks to seek or share information. Students engaged with trades-specific software applications like Autodata for Automotive Engineering and Fusion 360 for Mechanical Engineering, and these provided opportunities to connect with their respective communities and networks in which they expressed ideas in their language genres. One student revealed that he sent messages to a friend, an engineer, outside of his cohort for assistance. This student effectively drew upon his wider learning network within his community to seek further knowledge (Carvalho & Goodyear, 2014).

In addition, as the students engaged within these environments, they were learning about how to employ technical words specific to their trades via their language genres (Bakhtin, 2010b). For example, "glow plug," a type of spark plug used in diesel engines, represented a term specific to the Automotive Engineering community. An insulation tester, both term and tool, are used specifically in Electrical Engineering. Through the use of their materials, each case showed how "language is bound or fused to other materialities" relevant to a particular trade for each case (de Freitas & Sinclair, 2014, p. 111). In all, part of the dialogic activity involved these students navigating through their communities, networks, as well as digital and material activities, and utilising their trade-specific languages.

Having outlined key characteristics of emergent dialogues within the three case studies, I now turn to the three research questions in the study. To that end, in the next section, I answer the first research question: What dialogic activity emerges in a learning entanglement?

8.2 The Types of Dialogic Activity that Emerge in BL Contexts

The findings of this research showed that dialogic activity within each case included forms of shared knowledge, shared inquiry, and reflection, and drew upon communities and networks in connection with digital and material elements within diverse learning contexts. Rather than providing evidence of straightforward learning as a linear and procedural process, these components of dialogic activity, taken together, revealed learning to be a complex entanglement.

As an emergent phenomenon, dialogic activity cannot be entirely predicted in advance, but instead, it is understood as *influenced* or *shaped* by a combination of elements in a learning environment: the design of learning tasks, the social and physical configuration of the students, and the digital and material learning tools (Carvalho & Goodyear, 2014; Goodyear et al., 2021). Thus, dialogic activity is seen as relational, non-linear, and as including specific dependencies between heterogenous assemblages of humans (H) and things (T), through expressions of various possible dependences recalling human to human (HH), human to thing (HT), thing to human (TH), and thing to thing (TT) dependencies (Hodder, 2012).

Dialogic activity includes the foundational components of shared knowledge, shared inquiry, and reflection, which were identified within the vignettes in each case, irrespective of differences in context and in the assemblage of design elements of a course. As such, this research shows that dialogic aspects of activity were not specifically bound to learning design components. Dialogic activity emerged in a range of situations, as part of activities (e.g., planning a tack weld in "On planning") or as shared reflection (e.g., "On a torque wrench"), and was observed throughout the face-to-face sessions. Students occupied the dialogic spaces concurrent with most student activity (Wegerif, 2013).

In addition, dialogic activity was mediated by different language tools. These language tools included schematics as well as performing the language of mathematics. Schematics included representations that mediated students' activity, for example by conveying symbolic instructions for wiring their electrical boards. In addition, for all three cases, students employed the language of mathematics (e.g., in "On units of measure") to understand the properties of certain materials (e.g., to calculate motor efficiency). The application of mathematics sometimes aided in transforming the properties of things. This observation lends support to Mitra's (2011) claim that mathematics enables students to exert or change the qualities of the properties of the things they use which, in this research, could be seen when students calculated the efficiency of a motor, calculated voltage, or determined fuel efficiency.

Moreover, dialogic activity emerged as cumulative dialogues or dialogues that build constructively upon each other. Interestingly, two other types of learning dialogues, that Dawes et al. (2004), and Kershner et al. (2020) have described as disputational and exploratory, were not observed although one student indicated that he would sometimes engage in "friendly like competitiveness," alluding to the fact that disputational types of talk may have occurred. Dialogic activity was also shown to emerge from, and be mediated by, their trades communities, networks, and included trades-specific language genres, such as when students worked with exhaust systems on automobiles, or worked with insulation testers in Electrical Engineering, or used the plasma cutter in Mechanical Engineering (Bakhtin, 2010b; Goodyear et al., 2016; Lave & Wenger, 1991).

Overall, the three dialogic components of dialogic activity (shared knowledge, inquiry and reflection) form the foundational basis for learning dialogues, but these together were also influenced by the context, artefacts, designed tasks and the participants. The material and digital artefacts were shown to be bound within learning entanglements as well as other contexts, such as the communities and networks of students, within the observed dialogic activity. Figure 30 provides a graphic representation of dialogic activity involving humans, artefacts or things, thoughts, learning dialogues, activities, and dependencies. Note these elements most often overlap each other, showing that dialogic activity occurs at intersection of activity and thinking or speaking with things with oneself or others. The elements impact each other in multiple ways and represent the enmeshment or complexities of dialogic activity.

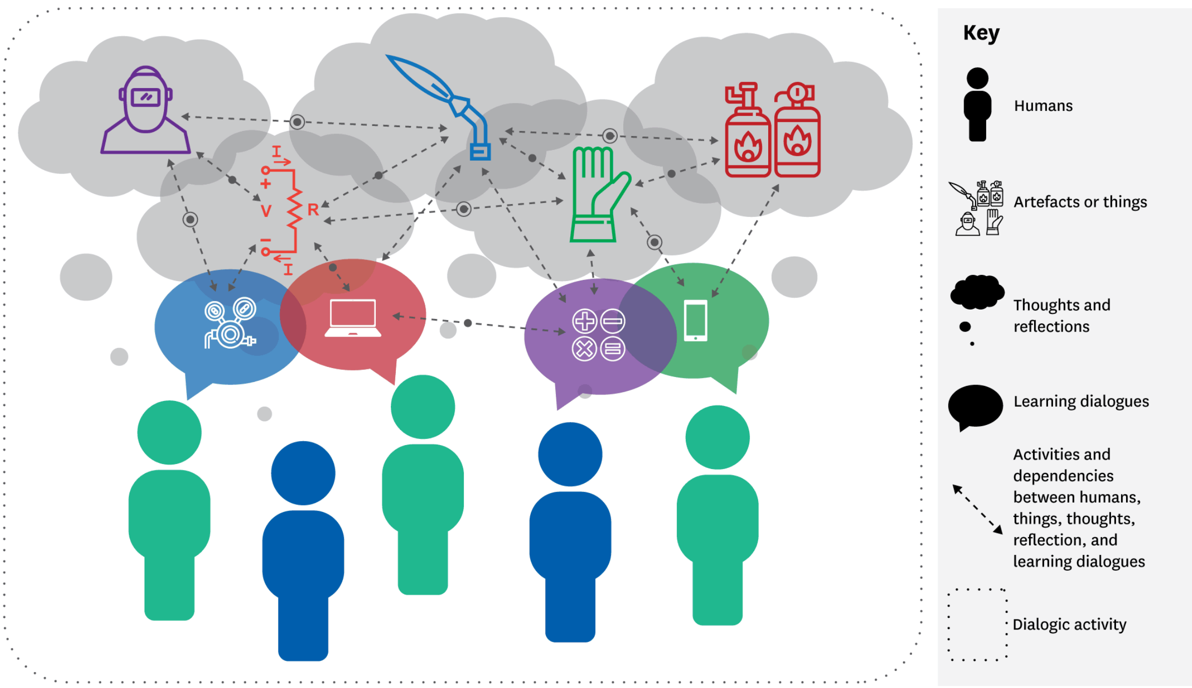


Figure 30. Dialogic activity.

8.2.1 The Ways in which Material and Digital Artefacts in Blended Learning Environments Impact Dialogic Activities

The second research question allowed me to explore dialogic activity in relation to artefacts or tools with a focus on the qualities and properties of them that influenced dialogic activity for each case. The reading of schematics and workbooks played an important role in the dialogic activity, as material assemblages within the BL environments. The properties of materials, and their materiality with respect to how they degrade or change, or how a student chose to work with them, had the potential to engender learning entanglements and impact dialogic activity (Brinkmann & Tanggaard, 2010; Cowie & Hipkins, 2014; Hennessy, 2011; Ingold, 2011; Otrel-Cass & Cowie, 2019). For example, in Automotive Engineering, the students misread the task instructions and burnt out a lightbulb on their UniTrain board in the vignette "On a mistake." The property of the material changed through a characteristic smell created by this transformation and students noticed their mistakes. Electrical Engineering students were constrained by the properties of electricity and could only work in fixed locations or workbenches to which the electrical power was wired for access, or as in the case with the "On disruptive support technology" vignette, in which a power outage caused a wi-fi and internet outage and interrupted students' studies. These examples illustrate specific dependencies between humans (H) and things (T) (Hodder, 2012), to the extent that students needed to be in certain locations to access and manipulate certain course tools (HT). These physical and digital tools and their properties mediated dialogues and activity (Mercer, Hennessy, & Warwick, 2019).

The artefacts or tools employed by students varied and included, but were not limited to, torque wrenches, MIG welding machines, steel tabs, personal computers, pens, scribes, and electricity and were part of the material assemblages of students' work. Many artefacts, such as engines, electrical motors and MIG welding machines, featured prominently in the material assemblages acted upon by the students and instructors. The students verbalised and shared knowledge, inquiry and reflection, while simultaneously touching and manipulating the artefacts (Hutchins, 2014; Hyland, 2019).

Digital artefacts and their properties also influenced students' material assemblages and might be perceived as more contemporary elements in the learning entanglements. The LMSs provided the tasks created for students' activity in both the digital and physical environments. They included Moodle for both Automotive Engineering and Electrical Engineering, with Mechanical Engineering using the Hapara LMS, an application that is used in conjunction with Google Classroom. For each case, the LMSs were used primarily for gaining access to course content or downloadable artefacts.

It was observed, however, that students used other tools or digital environments in addition to the LMS to aid them in their tasks. For each case, there were examples of students using Google, Facebook chat groups, or other tools to engage with course content or with other students for answers. In effect, the students extended their dialogic spaces into the digital spaces to interact with others and course content by means of chat or sharing images and content (Hennessy, 2011; Wegerif, 2013). In addition, two of the cases used industry-specific software to engage within their specific communities within these cases. Students drew on these learning networks to find solutions or to design projects collaboratively (Goodyear et al., 2016; Khoo & Cowie, 2018; Lave & Wenger, 1991; Mercer, Hennessy, et al., 2019). Although, it was found that the Electrical Engineering students did not utilise a genre-specific software package, but the students did use self-organised and self-regulated Facebook groups to engage with their peers. In fact, the students in each of the three cases used social media applications as a vehicle to share course content and share inquiry in relation to their course work.

It was found in this study that material and digital artefacts played a significant role in students' and instructors' dialogic activity. Again, the *things* were bound within their learning dialogues. Just as language and activity impacted each other, artefacts or materials were bound together. Such an entwinement is possibly especially significant within the rich trades training context.

Each case represented specific language genres and tools, or artefacts, bound to their respective trades and, when combined with students' engagement, these genres, tools and artefacts became integral to a complex learning entanglement. Interdependence between things and humans featured significantly within each case. Things or artefacts impacted humans, and the humans impacted the things or artefacts. What is more, artefacts or things were not restricted specifically to the learning environment, but featured in other situations such as planning and mimicry (Chan, 2020b; Hyland, 2019). Occasionally, the quality or properties of things degraded over time, such as the broken spark plug socket wrench, or engines missing parts, and these material *deficiencies* also played a role in students' dialogic activity (Hodder, 2012).

The complexity of the material artefacts sometimes impacted the digital properties of artefacts and vice-versa. For example, a (physical) electrical outage rendered wi-fi inaccessible (digital) and resulted in a student's (digital) photo being sent to peers for a solution (physical). Conversely, the physical properties of things prompted students to seek solutions digitally, such as a problem with an engine (physical) and to check the Moodle LMS (digital) for answers. These examples reiterated Hodder's (2012) point that dependencies emerge between things and humans and in this case, from the viewpoint of material assemblages, shown as TT and HT and the complexity of learning entanglements within these cases.

8.2.2 Flexible Learning Spaces and Environmental Conditions

The influence of flexible learning spaces in the dialogic activity was evident within the cases. For the Automotive Engineering case, the open plan nature of the automotive emulation lab and the engine bays provided many opportunities for incidental learning (Buntting, Jones, & Cowie, 2018), where the students were able to observe and participate in others' work or learning dialogues. The Electrical Engineering students' experience with space was perhaps more bounded to certain physical places, due to the need to access power points and kill switches for safety. Although each student worked in a fixed location, most students were able to walk freely and safely over to each other's work benches to discuss their tasks or borrow tools. The Mechanical Engineering students' experiences with the flexible learning spaces, however, varied. The only space the students could reconfigure were the breakout rooms which included moveable desks and chairs. Other than that, the Mechanical Engineering students worked on fixed metal work benches using specific, fixed equipment such as a mill machine, or MIG welding bays and others, which sometimes had additional requirements (for example, the MIG welding bays needed argon gas attached to the walls and the welding machines). However, the more open flexible spaces appeared to provide better opportunities for dialogic activity, even if sometimes students felt constrained by the small breakout rooms. Overall, the findings support the contention put forward by Hutchins (2010), Sørensen (2009), and (Yeoman, 2015) that the flexibility of learning spaces and the material assemblages available to students, influenced and mediated their social-material relationships. These spaces enabled the flow of humans and things and provided a scenario where heterogenous assemblages were part of complex dialogic activity.

The senses and environmental conditions played a significant role for each case in different ways. Mataaho is a large, open plan trades building with multiple cohorts of students conducting their work for different trades disciplines at the same time. Ambient noise and smell wafted throughout the building and the nature of the smell and noise depended upon the activity conducted in the space at the time, such as welding or using the plasma cutter. Inevitably, the activity from other student cohorts within this large building generated environmental conditions which could impact dialogic activity. Auditory sense was a significant factor in dialogic activity in the Electrical Engineering course during the first semester, during which many students resorted to using ear plugs to be able to conduct their work. For Automotive Engineering students, olfactory senses alerted students in the class to a burning smell from a burnt-out lightbulb. Smell also impacted the student learning experience in Mechanical Engineering, as did lighting. One student commented that the lighting made it particularly difficult to see his work, especially in the welding bays. The impact of smell, noise and lighting depended both on the type of activity and the number of students conducting an activity at the time. For example, an entire cohort of carpentry students hammering planks of wood created an overwhelming cacophony of noise that echoed throughout the entire building as it impacted many student cohorts within their vicinity, including the Automotive Engineering students. In various ways, then, the environmental conditions impacted students' learning experiences and entanglements, and influenced how students interacted with each other, their instructors and artefacts.

8.2.3 Embodiment, Multiplicity and Mediation

Embodiment, multiplicity and mediation emerged as underlying themes from the activity conducted in each case. For the Automotive Engineering students, working with the engines and tools by seeing, listening, doing and speaking with others provided them embodied experiences in their dialogic activity (Brinkmann & Tanggaard, 2010; Hutchins, 2014; Hyland, 2019). For the Electrical Engineering students, schematics mediated the embodied experience of translating instructions or tasks into dialogic activity (Vygotsky, 1997a, 1997b). In addition, for the Mechanical Engineering students, physical gesturing, learning dialogues and activity combined and mediated an embodied and shared reflective space within the course of their dialogic activity (Wegerif, 2006, 2013). For each case, embodiment and mediation occurred at the same time as learning dialogues in multiplicity (Bakhtin, 2010a, 2010b). That is, their embodied shared activity and dialogues mediated their dialogic activity in multiple ways. The flow and multiplicity of activity, in a heterogenous mix of artefacts and humans, created or dissolved assemblages of humans and things to produce learning entanglements and facilitate learning scenarios (Bakhtin, 2010b; Hodder, 2012; Sørensen, 2009).

8.2.4 Health and Safety

Health and safety played a paramount role in each case for both instructors and students. The first two weeks of each course focussed specifically on health and safety, legislation, reporting, specifications and PPE required for students to conduct their tasks safely. In addition, at the beginning of each observed session, health and safety matters for the day's tasks were discussed and students were required to conduct daily risk assessments. For some students from Automotive Engineering and Mechanical Engineering cases, the health and safety assessments were deemed somewhat excessive but, for all the instructors, health and safety was a primary concern. One instructor emphasised the point further by saying that if the students knew how to conduct the specific safety tests, he was satisfied with the students even if they learned nothing else. In this case the performance of health and safety tasks, aside from being a regulatory requirement in New Zealand, emulated what the students will encounter in the workplace (Worksafe NZ - Mahi Haumaru Aeotearoa, 2021). Health and safety requirements and tasks were therefore an important part of student and instructor dialogic activity.

8.3 Students' Perspectives of Dialogic Activity

As part of the third research question, I explored students' perspectives of dialogic activity in blended environments. While students did not necessarily know or understand the term, dialogic activity, they certainly understood that I was researching the way in which their learning dialogues impacted their activities and how their activities impacted their learning dialogues. The weekly questionnaires and student interviews provided opportunities for the students to express their perspectives about dialogic activity and learning entanglements that arose within BL environments.

Of the 14 students observed, 11 preferred working with hands-on tasks and the artefacts of their trades as their most favoured activities. For example, the Automotive Engineering students preferred working on the engines, the Electrical Engineering students preferred working on their wiring boards, and the Mechanical Engineering students preferred fabricating or manufacturing most, except for one student from this cohort who said that he preferred the examples provided by one of his instructors.

The participants from these cases enjoyed learning by doing and enjoyed conducting their work in the flexible learning spaces, if the environmental conditions did not become too disruptive to their work. An example of this was when the plumbing students worked on metal pipes near to the Electrical Engineering students during their first semester, forcing the Electrical Engineering apprentices to use ear plugs. Another example was the low lighting in the welding bays of Mataaho which made it challenging for students to see their work. Unsurprisingly, the Electrical and Automotive Engineering students felt that tool ownership was important to be able to learn their trades, such as toolkits with wrenches, screwdrivers, insulation testers and multi-meters. Whereas for the Mechanical Engineering students, the responses were mixed about tool ownership since most of the tools they used, such as welding machines and the mill, were large and not portable.

8.3.1 BL Designs and Observations

The third research question also related to students' experiences of their BL courses. Overall, students used the LMSs for downloadable content or for quizzes and activities. It was found that physical workbooks and worksheets were used within the Automotive Engineering cohort, and for the Electrical Engineering, alongside the digital content available through the LMSs. It was a challenge to determine the success of the BL designs from the LMS analytics reports because they displayed only student access, frequency of access, and downloadable content. The analytics did not provide sufficient information as to how students engaged with the on-page content. Furthermore, once content was downloaded, information as to how students engaged with it could not be measured. The one exception, however, is that the learning analytics showed an increase in students' frequency of LMS access near assessment dates for each case. Unsurprisingly, then, students accessed course content for assessment preparation. In addition, students did not use the LMS-provided discussion forums. Instead, students from each case participated in their own self-created and self-moderated discussion groups which served social purposes aside from educational ones.

However, printed handouts, workbooks and materials were predominantly used in the practical sessions to engage in their tasks. Sometimes the handouts were designed as tasks for the day such as the QR code activity for Electrical Engineering or were included in specific workbook packets, like Automotive Transmission and Driveline Systems for Automotive Engineering. In terms of the learning blend, the students utilised the digital programs such as the LMS, bespoke applications like Autodata, and social media applications like Facebook messenger as tools to access information or solutions when needed. Additionally, from the students' perspectives for each case, it was face-to-face aspects of the BL mix that played a more prominent role over the complementary digital course designs.

8.3.2 Importance of Class Culture

As Kim and Wilkinson (2019) have noted, classroom culture gives power to the classroom dialogue just as much as classroom dialogue gives power to classroom culture. Class culture and its role in facilitating a dynamic and collaborative learning environment emerged as a foundational theme in this study. Since I specifically chose to collect data in the second semester for each case, it was hoped that the students would have had prior opportunities to establish a rapport with each other. However, it was not known if the students would collaborate and engage in their work together as postulated. Through my observations, the importance of classroom culture underpinned all student activity. It was foundational to establishing a "safe" learning environment or one in which students felt sufficiently comfortable to engage collaboratively in learning dialogues and activity. It became very clear that students would not have engaged at this level of collaboration without the culture already established by their instructors and fellow students. The design of the in-class tasks, the students, the instructors, student groupings, materials used, the dialogic stances of the instructors, cumulative dialogues and language tools together converged to provide environmental conditions to facilitate this culture (R. Alexander, 2020; Carvalho & Goodyear, 2014; Chan, 2021; Goodyear et al., 2021; Kershner et al., 2020; Vygotsky, 1997a, 1997b). Data collection for this study would not have been possible if a level of conviviality had been absent among the students, their peers, and their course instructors.

9 Conclusion

In this chapter, I synthesize the main findings of this research in relation to each research question and provide concluding thoughts in relation to key points that warrant further attention. I also discuss the significance and contributions of this work and provide recommendations for further research.

9.1 The Emergence of Dialogic Activity in a BL Environment

Dialogic activity is present and ubiquitous in the tertiary trades BL environments. Forms of shared knowledge, shared inquiry and reflection were all present within the emergent dialogues. It was found that these foundational components of learning dialogues remained constant even as the environmental contexts, associated tasks, content, and social configuration of students and instructors changed. That is, the dialogic components of dialogic activity within the three tertiary trades environments, namely, shared knowledge, shared inquiry and reflection, together provided a foundational basis for simultaneous activity. Of particular interest was the finding that knowledge is developed in circular rather than linear fashion. Shared knowledge, inquiry and reflection were found to be recursive in that questions give rise to answers and answers give rise to questions. Within the specific learning environments investigated, shared knowledge, inquiry and reflection, as components of dialogic activity, mediated the learning dialogues and gave rise to other dialogic activity in other learning situations.

9.2 The Role and Impact of Material and Digital Artefacts on Dialogic Activity

Throughout this study, it became clear that material and digital artefacts mediated dialogic activities and the dialogic activities mediated the use of material and digital artefacts. Dialogic activities occupied dialogic spaces and were conducted simultaneously with some of the learning dialogues and were found to be cumulative in nature, by accumulating and building positively upon each other's ideas.

The dialogic aspect of dialogic activity emerged alongside the digital or physical forms of schematics, as the language of mathematics, and within student communities and networks, and within or outside of learning entanglements. That is, students' use of materials and artefacts varied within entanglements, according to the qualities of the properties of the things, the conjunctural problems that arose, and the artefacts students used to address these problems. It was found that the social configuration of the students, the digital and physical learning spaces used, and the tasks impacted on how students engaged with the artefacts in dialogic activity, in the simultaneity of the events (Bakhtin, 2010b; Carvalho & Goodyear, 2014; Goodyear et al., 2021; Hodder, 2012).

9.3 Students' Perspectives about Dialogic Activity in BL Environments

Unsurprisingly, above all other aspects, the students' most preferred activities were for the hands-on and material-based ones. These courses enabled students to conduct their work freely and collaboratively within their learning environments with many opportunities to engage in dialogic activity. In addition, it was found that the environmental conditions, specifically noise and smell within the setting, played a role in students' dialogic activity. For most of the students, tool ownership was considered important since it enabled students to assemble or transform their material artefacts in class. Computer use proved highly significant for the students because their BL courses were partially online, and they were sometimes required to learn industry-specific software such as Autodata and Fusion 360. During class, access to computers was equitable, since students used either loanable computers from Unitec, computers borrowed from their peers, or used their own computers to conduct their course tasks.

Based on findings from the data-collection methods of observation, reflection questionnaires, and interviews, the students participated in forms of shared knowledge, shared inquiry and reflection within their dialogic activities. Forms of these components emerged within all learning contexts and in varied forms of entanglements. At times, this involved both shared inquiry and knowledge such as a student asking a question and obtaining an answer. For some students, this engagement occurred as an act of checking their own knowledge against other students' knowledge. Some students extended their knowledge, inquiry and reflection into the digital or physical realms outside of their specific cohort to obtain answers. In addition, shared knowledge, inquiry and reflection occurred within utterances, written or digital forms. However, the findings revealed that students demonstrated their active engagement with dialogic activity when using the foundational components of shared knowledge, inquiry and reflection alongside their activity.

9.4 Additional Findings

This investigation established that the blended course designs impacted students' dialogic activities and were specific to the types of course designs and the tasks designed for each course. Dialogic activity formed a part of the students' learning experiences and was perceived by the students as part of their learning experiences. As noted earlier, students preferred the hands-on activities of the learning mix; they actively participated in their material and social assemblages throughout their courses. The flow of multiplicity, embodiment, and mediation of dialogic activity in a heterogenous mix of artefacts and humans created or dissolved other assemblages of humans and things. That is, the findings support Bakhtin (2010b) and Hodder's (2012) contention that dialogic activity is recursive in nature. However, what this research has highlighted is the significance of a safe, respectful, and collaborative classroom culture. These characteristics of the learning environment were critical to the establishment of conditions for dialogic activity to flow freely within them.

9.5 Significance of This Research

This study introduces and explores a phenomenon known as dialogic activity. It has established that learning settings that pay attention to the social, material, physical environments, tasks, and student configurations, are able to facilitate the emergence of learning. The study is also mindful of the fact that, in such settings, and as part of dialogic activity, humans hold agency and that things employed in their activity may degrade or change over time, creating conjunctural events or other emergent learning situations.

Dialogic activity acknowledges that classroom dialogues and the associated activity conducted within the physical and digital learning environments find their point of equilibrium. Students readily engage with their digital and physical environments and with artefacts in pursuit of inquiry or knowledge while engaged within reflective activity. To that end, dialogic activity is situated at the intersection of utterance, things, and activity. The ways in which these three aspects either intersect with ease or collide can be analysed and potential solutions can be sought to improve students' learning experiences.

9.6 Contributions

This research contributes to the bodies of knowledge developed in education and within dialogic and socio-materialist research. The theoretical development of dialogic activity draws together perspectives of entanglement theory and dialogism to gain new insights about relationships between the physical and the material, the dependencies between them, the artefacts used, and the social configuration of students and their activity. This study is significant in that, to date, minimal research has been conducted from the perspective of this interdisciplinary lens for tertiary trades education. The research provides an alternative perspective that allows it to shed light on the complexities of learning dialogues within material-rich tertiary educational settings. In doing so, it offers potential transferability to other material-rich tertiary learning environments such as in health and medical sciences. This piece of research, then, signifies that dialogic activity is a unique phenomenon which warrants further exploration (Bakhtin, 2010a, 2010b; Carvalho & Goodyear, 2014; Goodyear et al., 2021; Hodder, 2012).

9.7 Recommendations for Future Research

This study highlighted several potential areas for future research in dialogic activity and these are outlined in the following sections.

9.7.1 Reframed ACAD framework

The ACAD framework by Carvalho and Goodyear (2014; 2021) utilised in this study was employed to explore the learning design of a number of courses. It was used to observe dialogic activity as an emergent entity in multiple learning situations and entanglements. The authors, Carvalho and Yeoman (2018), utilised a reframed version of the ACAD framework by applying macro, meso, and micro structures to the set design, epistemic design and social designs. That is, this reframed ACAD framework helped to identify different structural patterns, at the micro or student/instructor level, the meso or the classroom, curriculum and spaces used level, or the macro level or type of learning blend and its support structures, such as at the wider infrastructure to maintain learning management systems, to frame learning entanglements (Carvalho & Yeoman, 2018). The application of these multiple levels at each dimension of the ACAD framework might be drawn upon in further research to investigate the complexities of dialogic activity in course designs as part of a wider ecosystem.

9.7.2 Analogies, dialogic stance, alternate contexts and redesigns

Analogies, and their role within dialogic activity, are a possible topic of study for future research. In this research, within the Electrical Engineering course, the analogy of a river was employed to bridge the unknown to the known by describing electricity as a river in the vignette "On flow." Research specific to the role of analogies within dialogic activity offers potential.

In addition, explorations of instructors' dialogic stance and their use of "repertoires" within the tertiary trades environment holds promise for further research (R. Alexander, 2020). That is, the instructors' skills and/or the repertoires they use to organise and interact with students, including their purposeful use of dialogues, could be investigated.

A further research pursuit may include the potential application of dialogic activity associated with other educational disciplines and contexts, such as medical and health sciences, to highlight how it may emerge and its potential differences to dialogic activity within trades disciplines. In addition, courses that include purposefully redesigned tasks, involving different dialogic types such as exploratory and playful dialogues or the role modelling of them by the instructors, or both, warrant further research (Kershner et al., 2020; Mercer, 1994, 1995). Another alternative might include a comparative study of this research's findings alongside a study in a post-Covid environment to determine how dialogic activity emerges, or how course designs have changed or altered the way in which dialogic activity emerges since the pandemic.

9.7.3 Investigation of dialogic activity and its impact on retention rates

The intent of this research was to consider BL course designs to determine what dialogic activity emerges, how materials and artefacts impact them, and students' perspectives about them. Given that dialogic activity has now been identified as an emergent phenomenon within BL course environment designs, further research into understanding its role or impact, if any, on tertiary trades retention rates is warranted.

9.7.4 Policy, instructor training, and other dialogic types

Future research might include ways to include or engender dialogic activity in tertiary trades environments by way of institutional or faculty-level policymaking aside from accreditation requirements for these courses. In addition, activities and tools to support dialogic activity can be designed and taught to instructors to aid their course designs. That is, instructors can be purposefully trained in how to redesign tasks or assignments to elicit specific dialogue types, such as exploratory or playful dialogues, in dialogic activity to make thinking more visible to their students in these material-rich learning environments (Chan, 2020a, 2021; Kershner et al., 2020; Mercer, 1994, 1995).

9.8 Final Word

This research represents the beginning of my journey into the investigation of the phenomenon, dialogic activity. The findings of this study will benefit my work as a learning designer in assisting lecturers with course designs in which students can be actively and positively engaged with what they say and do as they learn. My hope is that the findings will assist other learning designers, facilitators, and instructors, particularly those working within the tertiary trades environment to pay equal attention to their BL course designs and the role of humans and materials or artefacts within them. A tertiary trades environment that is focused on course design that enhances students' learning experiences may go some way towards improving the current trades retention rates in the future as well as provide opportunities to facilitate and augment dialogic activity.

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Appendix A – Massey Ethics Approval Letter

Date: 10 May 2018

Dear Ann Simpson

Re: Ethics Notification **- NOR 18/14 - Artefacts, People, & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Tertiary Setting**

Thank you for the above application that was considered by the Massey University Human Ethics Committee: **Human Ethics Northern Committee** at their meeting held on **Wednesday, 9 May, 2018**.

Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

Associate Professor Tracy Riley, Dean Research

Acting Director (Research Ethics)

Research Ethics Office, Research and Enterprise

Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand **T** 06 350 5573; 06 350 5575 **F** 06 355 7973

E humanethics@massey.ac.nz **W** http://humanethics.massey.ac.nz

Appendix B – Unitec Ethics Approval Letter

Tuesday 5th June

Kia ora **Ann Simpson,**

Re: Research Site Approval for *Artefacts, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting*

This is a letter to advise that permission from the Unitec Dean, Research and Enterprise to conduct research on Unitec premises has been granted to you, commencing today **(5 June 2018)**.

Please note that this approval will be noted by the Unitec Research Ethics Committee (UREC) at the committee meeting to be held on **20 June.**

Wishing you the very best with your intended research.

Nga mihi,

Marcus Williams
Dean, Tuapapa Rangahau; Partnering Research and Enterprise
Unitec Institute of Technology
139 Carrington Rd
Mt Albert
Auckland 1142
Email: mwilliams@unitec.ac.nz

Appendix C – Māori Advisor Participation Approval Letter

Re: Invitation to participate

Ann Simpson
Fri 23/03/2018 8:55 a.m.
To MaryAnn Lee <maryann@rautaki.co.nz>;

Kia ora Maryann,

Thank you for accepting my invitation. I will contact you accordingly and I look forward to working with you.

Nga mihi,

Ann Simpson
Academic Advisor I Te Puna Ako
Email asimpson@unitec.ac.nz Mob +64
(021) 526 669 or X8313
Unitec Institute of Technology I Te Whare
Wänanga o Wairaka Private Bag 92025, Victoria
Street West, Auckland 1142 www.unitec.ac.nz

From: Maryann Lee
<maryann@rautaki.co.nz> Sent:
Friday, 23 March 2018 8:52 a.m.
To: Ann Simpson
Subject: Re: Invitation to
participate

Kia ora Ann,

I would be happy to provide any support or guidance in terms of research on Maori students. A Kaupapa Maori research approach is important to acknowledge and understand when working with Maori participants. It would be critical for you to be familiar with this methodology if you were to have Maori participants, or your work involved Maori settings.

Nga mihi nui,

Maryann

On 23 March 2018 at 06:56, Ann Simpson <asimpson@unitec.ac.nz>

wrote: Mörena Maryann!

I hope this email finds you well! I am a doctoral student, as you know at Massey University and 1 [1] m getting ready to submit my ethics application and associated documents for my research. A part of my ethics application requires me to seek advice, when required during my research for Mäori volunteer students. The research centers around Level 3 Certificate courses in Mechanical Engineering, Automotive Engineering, and Carpentry. I hope to follow 4 students in each class for the semester next term. I may or may not have Mäori student volunteers, but if I do 1 [1] m required to consult with a Mäori advisor.

Would you be willing to assist me in this effort? I ⁱd be so honoured if you could. If you accept this invitation, if you could please answer, this email that you accept and I will include this letter in my ethics application.

Here is a summary of my research:

For the past four years, the successful graduation rate for students of Level 3 courses has steadily declined.

In 2016 53% of those who enrolled in Levels 1-3 certificate courses completed them ("Retention and Achievement," 2017). Trades courses are one of several areas that are high priority for the New Zealand government since an increase in demand for them is expected ("Tertiary Education Strategy 2014-2019," 2014). Research suggests that the ways in which students interact with each other through educational dialogues and the tools and spaces available to them, both digital and physical, can potentially impact how they learn (Carvalho, Goodyear, & de Laat, 2016; Wegerif, 2006). The goal of the proposed study is to use student voices, or dialogues, as a window to their learning experiences to throw light on those factors that contribute to successful learning. The study seeks to identify possible ways to improve the blended learning experiences of students in vocational training programmes. The sample for the study will be 4 students and 3 instructors from three courses (12 students in total) at a vocational institute. The research involves tracking their progress through the 14 weeks of their course training. The researcher will observe participant students once a week, collecting video recordings and interview audio data related to their understanding of activities and tasks they are completing. When studying online, students will keep logbooks of their learning interactions, which they will also share with the researcher. Students and instructors will be interviewed. The findings will illuminate connections between pedagogical design and practices, as well as the learning experiences of students. Findings will also suggest ways to improve design for learning in vocational training programmes. Thank you so much for your consideration.

Ann Simpson
Academic Advisor I Te Puna Ako
Email asimpson@unitec.ac.nz Mob +64 (021)
526 669 or X8313

Appendix D – Letter of Introduction

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Ann Simpson
Doctoral Student
Unitec, Mt. Albert Campus

Engineer Construction & Infrastructure Network
Vehicle Systems & Materials Practice Pathway HoPP
Engineering Practice Pathway HoPP
Level 3 Certificate of Mechanical Engineering, Automotive Engineering, & Electrical Engineering
Programme Leaders
Relevant Instructors
Unitec, Mt. Albert, Auckland

Hello!,

My name is Ann Simpson and I am an academic advisor with Unitec. I am also currently a doctoral student at Massey University, in the Institute of Education. I'm requesting permission to conduct my intended research project called Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting at Unitec. The research investigates volunteer students and instructors from Level 3 Certificate courses including Mechanical Engineering, Automotive Engineering, and Electrical Engineering. The ethics approval process has been undertaken through Massey University and Unitec and the approval letters are attached to this email.

For your convenience, the summary of the research is as follows:

> For the past four years, the successful graduation rate for students of Level 3 courses has steadily declined. In 2016 53% of those who enrolled in Levels 1-3 certificate courses completed them ("Retention and Achievement," 2017). Trades courses are one of several areas that are high priority for the New Zealand government since an increase in demand for them is expected ("Tertiary Education Strategy 2014-2019," 2014). Research suggests that the ways in which students interact with each other through educational dialogues and the tools and spaces available to them, both digital and physical, can potentially impact how they learn (Carvalho, Goodyear, & de

Laat, 2016; Wegerif, 2006). The goal of the proposed study is to use student voices, or dialogues, as a window to their learning experiences to throw light on those factors that contribute to successful learning. The study seeks to identify possible ways to improve the blended learning experiences of students in vocational training programmes. The sample for the study will be 4 students and relevant instructors from the three courses (12 students in total) at Unitec. The research involves tracking their progress through the 14 weeks of their course training in the Mataaho building. The researcher will observe participant students once a week, collecting video recordings and interview audio data related to their understanding of activities and tasks they are completing. Once a week, students will answer a digital questionnaire of their learning activity which they will share with the researcher. Students and instructors will be interviewed. The findings will illuminate connections between pedagogical design and practices, as well as the learning experiences of students. Findings will also suggest ways to improve design for learning in vocational training programmes.

Thank you so much for your assistance! Please don't hesitate to ask me if you have any questions.
I will be in touch to set up a meeting time that works for you to obtain your permission and determine what works best for you.
The relevant files are attached.

Kind regards,

Ann Simpson

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

INSTRUCTOR INFORMATION SHEET

Researcher(s) Introduction
My name is Ann Simpson and I am conducting this project as part of research for a Doctorate in Education under the supervision of Prof. Margaret Walshaw, Assoc Prof. Lucila Carvalho, Dr. Jayne Jackson, through Massey University Institute of Education at the Albany campus in Auckland. This project aims to explore the use of dialogue and activities in blended learning classrooms at Unitec.

Project Description and Invitation
This project investigates learning conversations or dialogues that emerge through activities in blended classroom spaces, both in physical and digital spaces. The proposed study will be conducted over the period of 1 semester and will involve 3 instructors from 3 level 3 certificate courses and observations of 4 student volunteers in each course. The data collection will involve videotaping of face-to-face sessions, gathering of materials or artefacts produced for the face-to-face sessions and/or the online tools used in the course (e.g., discussion forums in Moodle or Facebook), and toward the end of the project instructor and student interviews. I would like to invite your participation.

If you agree, I will observe the activity in your class, focusing on 4 volunteer students during each session. I will also take digital pictures or screen shots of the materials students create online and in the face-to-face activities for example, a Moodle forum or writing on the whiteboard. In the face-to-face sessions, I will video record how the group of students engage in the course work and activities through discussion on a smartphone. When appropriate, and with as minimal disruption as possible, I may approach you or your students to ask questions about what you and/or your students are doing or have just done. Most of the time I will be taking observation notes. With your permission, I will advise all the students in the class that I will be recording only volunteer students and their activities. You, the instructor, will sometimes be captured in the recording if within the vicinity of the volunteers.

Your participation in this study will be anonymous. Videodata and images will be de-identified (by blurring faces). Your students' participation will be anonymous, and all information and materials collected will be kept confidential.

Your name and the students' names will be removed, and a number or pseudonym used to identify the data. The programme and teaching unit will not be identified. Data, including video, images and notes will be stored in password protected computers and will not be discussed with anyone apart from my supervisors.

At the completion of the study, raw data will be stored securely for 5 years and then destroyed in a secure and confidential manner. Research outputs will be in the form of thesis chapters outlining findings and may inform journal articles or conference presentations.

You will be offered to receive a summary of information about the study when it is complete if you choose to participate.

Participant's Rights for data collection and interview participation
You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- withdraw from the study at any time.
- ask any questions about the study at any time during participation.
- provide information on the understanding that your name will not be used unless you give permission to the researcher.
- be given access to a summary of the project findings when it is concluded.
- decline to answer any question.
- ask for the video recording to be turned off at any time during the face-to-face sessions.

If you have any comments or questions regarding the study, please contact me at Ann.Simpson.1@uni.massey.ac.nz ([redacted]) or speak with my supervisors:

- Prof Margaret Walshaw M.A.Walshaw@massey.ac.nz, Extn 84404
- Dr Lucila Carvalho, L.Carvalho@massey.ac.nz, Extn 49086
- Dr Jayne Jackson J.HJackson@massey.ac.nz, Extn 43527

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application **NOR 18/14**. If you have any concerns about the conduct of this research, please contact A/Prof David Tappin, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43384, email humanethicsnorth@massey.ac.nz.

Appendix F – Instructor Consent Form

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

INSTRUCTOR CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

- I understand that none of my identifying details will be shared by the researcher.
- I agree/do not agree (please circle one) to the collection of materials in class and online (in the course Moodle webpage) and other relevant course digital tools.
- I agree/do not agree (please circle one) to appearing in the class video that will be recorded.
    - If not, I agree to be out of range of the camera during the recording.
- I would/ would not (please circle one) like to receive a summary of information about the study when it is complete. If so, please write your email address to the bottom of this form.
- I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name printed: ....

Email address: ....

Appendix G – Research Introduction Dates

Week 1 of 2nd semester 2018, Unitec

Cohort	***Introduction Date***
Automotive Engineering	30/07/18
Electrical Engineering	31/07/18
Mechanical Engineering	01/08/18

Appendix H – Student Observation Information Sheet

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

STUDENT INFORMATION SHEET

Researcher(s) Introduction
My name is Ann Simpson, and I am conducting this project as part of research for a Doctorate in Education under the supervision of Prof. Margaret Walshaw, Assoc Prof. Lucila Carvalho, Dr. Jayne Jackson, through Massey University Institute of Education at the Albany campus in Auckland. This project aims to explore the use of dialogue and activities in blended learning classrooms at Unitec.

Project Description and Invitation
Your lecturer has kindly agreed to take part in this study and allowed me to observe and film up to 4 volunteer students during each class session for the entire semester. I will be focusing on how students use dialogue in their learning activities and the materials they create, both digitally and in the face-to-face sessions. If you agree in participate in this study, I will record digital video on how you and other students engage in the course work and activities in the face-to-face sessions. I will take digital pictures or screen shots of artefacts you create in the face-to-face sessions and in the online environments you use, for example, a Moodle forum or writing on the whiteboard. I may sometimes ask questions to understand what you are doing, and with your permission I will audio or video record your answers. I will also take field notes of my observations. I will ask that you answer a questionnaire that will take approximately 10 minutes or less, by filling in an online form once a week that asks you a few questions about your learning activity in that week. Towards the end of the semester, a short interview will be conducted with the volunteer teachers and students participating in the study.

Your participation and that of your lecturer in this study will be anonymous and all information and materials collected will be kept confidential. Your name and the instructor's name will be removed from any data collected, and a number or pseudonym used to identify the data. The programme and teaching unit will not be identified. Data, including video and images will be de-identified (by blurring faces) and notes will be stored securely and will not be shared with anyone apart from my supervisors.

I would like to invite your participation. This would require your participation in the regular class activity while I observe and videotape your interactions. If you prefer not to be video recorded, but you consent that I analyse your online interactions, you can choose to be seated out of range of the camera. Your participation in this study will not impact your grade for the course in any way.

Data Management
At the completion of the study, raw data will be stored securely for 5 years and then destroyed in a secure and confidential manner. Research output will be in the form of thesis chapters outlining findings and may inform journal articles or conference presentations.

You will be offered to receive a summary of information about the study when it is complete if you choose to participate.

Participant's Rights for data collection and interview participation
You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- withdraw from the study at any time.
- ask any questions about the study at any time during participation.
- provide information on the understanding that your name will not be used unless you give permission to the researcher.
- be given access to a summary of the project findings when it is concluded.
- decline to answer any question.
- ask for the video recording to be turned off at any time during the face-to-face sessions.
- ask for the audio recorder to be turned off at any time during the interview.

If you have any comments or questions regarding the study, please contact me at Ann.Simpson.1@uni.massey.ac.nz ([redacted]) or speak with my supervisors:

- Dr. Margaret Walshaw M.A.Walshaw@massey.ac.nz, Extn 84404
- Dr. Lucila Carvalho, L.Carvalho@massey.ac.nz, Extn 49086
- Dr. Jayne Jackson J.HJackson@massey.ac.nz, Extn 43527

Committee Approval Statement
This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application18/14. If you have any concerns about the conduct of this research, please contact A/Prof David Tappin, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43384, email humanethicsnorth@massey.ac.nz.

Appendix I – Student Observation Consent Form

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

STUDENT OBSERVATION CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

- I understand that none of my identifying details will be shared by the researcher.
- I agree/do not agree (please circle one) to the collection of materials in class and online (in the course Moodle webpage) and other relevant course digital tools.
- I agree/do not agree (please circle one) to appearing in the video that will be recorded.
    - If not, I agree to be out of range of the camera during the recording.
- I agree/do not agree (please circle one) to fill out the weekly online student questionnaire.
- I would/ would not (please circle one) like to receive a summary of information about the study when it is complete. If so, please write your email address to the bottom of this form.
- I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name printed: ....

Email address: ....

Appendix J – Instructor Interview Information Sheet

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

INSTRUCTOR INTERVIEW INFORMATION SHEET

Researcher(s) Introduction

My name is Ann Simpson, and I am conducting this project as part of research for a Doctorate in Education under the supervision of Prof. Margaret Walshaw, Assoc Prof. Lucila Carvalho, Dr. Jayne Jackson, through Massey University Institute of Education at the Albany campus in Auckland. This project aims to explore the use of dialogue and activities in blended learning classrooms at Unitec.

Project Description and Invitation

This project investigates learning conversations or dialogues that emerge through activities in blended classroom spaces, both in physical and digital spaces. The proposed study will be conducted over the period of 1 semester and will involve 3 instructors from 3 level 3 certificate courses and observations of 4 student volunteers in each course. The data collection will involve videotaping of face-to-face sessions, gathering of materials or artefacts produced for the face-to-face sessions and/or the online tools used in the course (e.g., discussion forums in Moodle or Facebook), and toward the end of the project instructor and student interviews. This project is at the interview stage, and I would like to invite your participation in the instructor interview.

Participant Identification and Recruitment

Instructors who participated in the student recorded face-to-face sessions and materials and artefact collection phase of this project are being cordially invited to participate in instructor interviews. You may have volunteered to participate in the first phase and if so, thank you very much again.

Project Procedures

If you agree, you will take part in one semi-structured interview lasting approximately a half hour. I may ask you to share with me any materials or documents that are discussed in the interview. The interview will be audio recorded and transcribed, and you will be given the opportunity to review the transcript.

Data Management

Participation in this study will be confidential and anonymous. Names will be removed, and numbers or pseudonyms used to identify data. The institution and teaching unit will not be identified. Data, including any interview content and responses will be stored securely and will not be discussed with anyone apart from my supervisors. If you prefer that your contributions in terms of specific teaching approaches or materials, be acknowledged by using your name, this will be done, while keeping your other comments confidential.

At the completion of the study, raw data will be stored securely for 5 years and then destroyed in a secure and confidential manner. Research output will be in the form of thesis chapters outlining findings and may inform journal articles or conference presentations.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- decline to answer any question.
- withdraw from the study at any time.
- ask any questions about the study at any time during participation.
- provide information on the understanding that your name will not be used unless you give permission to the researcher.
- be given access to a summary of the project findings when it is concluded.
- ask for the recorder to be turned off at any time during the interview.

If you have any comments or questions regarding the study, please contact me at Ann.Simpson.1@uni.massey.ac.nz ([redacted]) or speak with my supervisors:

- Prof Margaret Walshaw M.A.Walshaw@massey.ac.nz, Extn 84404
- Dr Lucila Carvalho, L.Carvalho@massey.ac.nz, Extn 49086
- Dr Jayne Jackson J.HJackson@massey.ac.nz, Extn 43527

Committee Approval Statement

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Appendix K – Instructor Interview Consent Form

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

INSTRUCTOR INTERVIEW CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time. I understand that a transcript of the recording will be sent to me for my review.

- I agree/do (please circle one) not agree to the interview being sound recorded.
- I wish/do not wish (please circle one) to have my recordings returned to me.
- I wish/do not wish (please circle one) to have data placed in a secure archive.
- I wish/ do not wish (please circle one) to supply materials related to the pedagogies or practices that are discussed.
- I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: **Date:**

Full Name printed:

Email address:

Appendix L – Instructor Interview Guide

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Artefacts, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

Instructor Interview Guide

Instructor: ____________________ **Date:** ____________

1. How would you describe the design of your course? (blended, self-directed? etc)
2. How would describe the nature of activities designed for your course?
3. Based on your course design, what designed activities enabled students to share knowledge?
4. Did students engage in shared knowledge activities? If so, how?
5. Based on your course design, what designed activities enabled students to share inquiry?
6. Did students engage in shared inquiry activities? If so, how?
7. Based on your course design, what designed activities enabled students to self-reflect on their learning?
8. Did students engage in self-reflection? If so, how?
9. In what ways do you think your course needed improvement?
10. In what ways do you think your course was successful?

Appendix M – Student Interview Information Sheet

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

STUDENT INTERVIEW INFORMATION SHEET

Researcher(s) Introduction
My name is Ann Simpson, and I am conducting this project as part of research for a Doctorate in Education under the supervision of Prof. Margaret Walshaw, Assoc Prof. Lucila Carvalho, Dr. Jayne Jackson, through Massey University Institute of Education at the Albany campus in Auckland. This project aims to explore the use of dialogue and activities in blended learning classrooms at Unitec.

Project Description and Invitation
This project investigates learning conversations or dialogues that emerge through activities in blended classroom spaces, both in physical and digital spaces. The proposed study will be conducted over the period of 1 semester and will involve 3 instructors from 3 level 3 certificate courses and observations of 4 student volunteers in each course. The data collection will involve videotaping of face-to-face sessions, gathering of materials or artefacts produced for the face-to-face sessions and/or the online tools used in the course (e.g., discussion forums in Moodle or Facebook), and toward the end of the project instructor and student interviews. This project is at the interview stage, and I would like to invite your participation in the student interview.

Participant Identification and Recruitment
Interview participants are being recruited from the volunteer students who participated in the face-to-face sessions and materials and artefact collection phase. You may have volunteered to participate in this phase and if so, thank you very much again.

Project Procedures
If you agree, you will take part in one semi-structured interview lasting approximately a half hour. I may ask you to share with me any materials or documents that are discussed in the interview. The interview will be audio recorded and transcribed, and you will be given the opportunity to review the transcript.

Data Management
Participation in this study will be confidential and anonymous. Names will be removed, and numbers or pseudonyms used to identify data. The institution and department will not be identified. Data, including any interview content and responses will be stored securely and will not be discussed with anyone apart from my supervisors.

At the completion of the study, raw data will be stored securely for 5 years and then destroyed in a secure and confidential manner. Research output will be in the form of thesis chapters outlining findings and may inform journal articles or conference presentations.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- decline to answer any question.
- withdraw from the study at any time.
- ask any questions about the study at any time during participation.
- provide information on the understanding that your name will not be used unless you give permission to the researcher.
- be given access to a summary of the project findings when it is concluded.
- ask for the recorder to be turned off at any time during the interview.

If you have any comments or questions regarding the study, please contact me at Ann.Simpson.1@uni.massey.ac.nz ([redacted]) or speak with my supervisors:

- Prof Margaret Walshaw M.A.Walshaw@massey.ac.nz, Extn 84404
- Dr Lucila Carvalho, L.Carvalho@massey.ac.nz, Extn 49086
- Dr Jayne Jackson J.HJackson@massey.ac.nz, Extn 43527

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application **NOR 18/14**. If you have any concerns about the conduct of this research, please contact A/Prof David Tappin, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800 x 43384, email humanethicsnorth@massey.ac.nz.

Appendix N – Student Interview Consent Form

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Things, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

STUDENT INTERVIEW CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time. I understand that a transcript of the recording will be sent to me for my review.

- I agree/do (please circle one) not agree to the interview being sound recorded.
- I wish/do not wish (please circle one) to have my recordings returned to me.
- I wish/do not wish (please circle one) to have data placed in a secure archive.
- I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: **Date:**

Full Name printed:

Email address:

Appendix O – Student Interview Guide

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Artefacts, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

Student Interview Guide

Date:

Student:

1. What were your favourite activities to do in the course in the face-to-face sessions? Why?
2. What were your least favourite activities to do in the online environments? Why?
3. Have you used any other tools, like web pages or apps, or your own equipment, for example, your own wrenches while you were doing the class activities? If so, why?
4. Did you share those tools and/ or gear with any of your classmates? Why?
5. If you have any questions about the course or the information delivered in it, how did you go about getting the information you needed? Why?
6. Did you or any of your classmates share information that you needed? Why?
7. How did you like taking the course in the learning spaces at Mataaho? Why?
8. Did you have any favourite learning spaces in Mataaho? Why?
9. Were there any least learning favourite spaces in Mataaho? Why?

Appendix P – Student Observation Sheet

Look at what is planned for class on the day - Look at online materials if any in preparation for the class
*Just before class starts - Set up camera and tripod. Get phone and journal ready.

During Observation

Details	**Observation**	**Observations of note**
Class: Date: Time: Main topic of the day: Who: Who with: Artefacts: Space:	What I saw/What happened with whom Shared knowledge Shared inquiry Reflection	note any interesting/ significant activity

After Observation

Distil thoughts from observations and my interpretations afterward.

Appendix Q – Weekly Reflections Questionnaire

MASSEY UNIVERSITY

INSTITUTE OF EDUCATION

TE KURA O TE MĀTAURANGA

Artefacts, People & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Setting

Weekly Student Reflections Questionnaire
Thank you for filling this out today.

Your Name: ...... **Date:** ......

1. In what ways did you share your knowledge with others about the course content this week?

2. In what ways did you share your questions with others about the course content this week?

3. In what ways do you think you've improved in your coursework this week?

4. In what ways do you think you need to improve?

Appendix R – Observed Artefacts

** Automotive Engineering (AE), Electrical Engineering (EE), Mechanical Engineering (ME). Mataaho floor plans are included in Chapter 4, section 4.2.4 Site Selection.

Cohort**	Space(s)	Artefact(s)	Description/ Purpose
AE	**Automotive Emulation Lab**, Mataaho 307-2028	Circuitry boards, voltage meters, wires, lightbulbs, wrenches, screwdrivers, Lucas Nuelle simulation equipment, UniTrain electrical boards connected to computer workstations, website links, software on the computers	An automotive emulation lab designed to emulate tasks students will conduct in an Automotive Engineering environment.
AE	**Canopy**, Mataaho 307-1004 and **WOF**, Mataaho 307-1033 area	Cars in working order and cars with missing parts or defects, handouts, website links, ear protection, eye protection, cotton coveralls, high visibility vests, and steel capped boots.	Students were assigned multiple tasks in terms of assessing and repairing cars. E.g., Warrants of Fitness (WOF) worksheets,
AE	**Chassis, Engines, Electronics**, Mataaho 307-1034, **Dismantle & Reassemble**, Mataaho 307-1036	Safety handout, handouts, workbooks, Moodle links, cars, fuel lines, exhaust systems, engines on wheels (both diesel and petrol), sparkplugs, electronic fuel injection systems, oils, fuels, rags, tool sets (both provided ones and ones students purchased), lubrication and cooling systems, diesel and petrol engines, HVAC (heating, ventilation and air conditioning) systems, pistons, torque wrenches, vices, transmissions and driveshafts, hoists, ear protection, eye protection, cotton coveralls, and steel capped boots.	Tasks involving many components of a vehicle including testing, assessing, and repairing.
AE	**Room 113-1035**, dependent upon availability	Safety handouts, Moodle site, handouts, workbooks, digital video site links	Theory delivery sessions covered safety and tasks involving worksheets and group work to augment the practical sessions.
EE	**Electrical Wiring**, Mataaho, 307-1014	Safety handouts, white board, markers, website links, Moodle site, handouts, workbooks, electrical motors, voltage multi-meters, testing equipment, earthing their boards, wiring electrical boards, including switches, resistors, CSIR – capacitor start inductive run motors, CSCR – capacitor start capacitor run motors,	Tasks involving the components for wiring, testing and using multiple tools to wire electrical boards, motors, switches and their components.

Cohort**	Space(s)	Artefact(s)	Description/ Purpose
		RSIR – resistor start induction run motors, shaded pole motors, motor efficiency, parallel circuits, series circuits, contactors, control circuits for contactors, wires, wire cutters, stop switches, efficiency formulae handouts, wattage and power handouts, 3 phase motor terminals, wiring schematics, phase failure phase reversal and overload protection in 3 phase circuits, polarity testing with multi-meters, ear protection, eye protection, steel capped boots, tool sets (both provided ones and ones students purchased), cell phones, computers, paper, and messaging programmes.	
EE	**Room 183 – 1045**	Moodle site links, handouts, physical exemplars passed around the room such as switches, old assessment handouts, website links, A frame whiteboards, markers, erasers, computers, cell phones, paper, pens or pencils, moveable and configurable tables and chairs, and instructor computer on wheels (COW), computers, cell phones, notebooks, pen, and paper.	The theory sessions discussed safety, the maths, and physics behind the tasks as well as the relevant information required for the day's tasks in the practical session.
ME	**CNC** (computer numerically controlled machines) **Set**, Mataaho 307-1032, **Welding Bay**, Mataaho 307-1064, Grinding Room, Mataaho 307-1062	Safety handouts, MIG (metal inert gas) welding machine, wire for MIG machine, argon gas, welding helmets, metal plates, gloves, leather aprons, cotton coveralls, steel plates for welding, ear protection for grinding, eye protection, steel capped boots, tools (both provided ones and ones students purchased), fume hoods, jigs, computers, cell phones, workbooks, Hapara LMS, Fusion 360 (CAD programme), messaging programmes, drill, plasma cutter, files, hammers, mallets, and vices.	Tasks designed to plan, draw, and manufacture components and projects.
ME	**Breakout rooms**, Mataaho 307-1048 & 1060	Whiteboards, markers, erasers, configurable desks and chairs, computers, handouts, wall-mounted lecture monitor, paper, notebooks, pens, and pencils.	Theory sessions regarding welding, manufacturing theories and processing,

Appendix S – Cohort, LMS, and Required Software

Cohort	***LMS & Digital System***
Automotive Engineering	Moodle and Autodata
Electrical Engineering	Moodle
Mechanical Engineering	Hapara and Fusion 360

Appendix T – Extension of Ethics Approval

Foreman, Mon, Mar 1, 2021, 7:52 AM

Hannah <H.Foreman@massey.ac.nz>

to Human Ethics,

Kia ora Ann,

Re: NOR 18/14 – Things, People, & Classrooms: A Study of Dialogue and Blended Learning in a Vocational Tertiary Setting

Thank you for your email. Your extension has been noted. Given that no further data will be collected, and only the thesis will be written up, no further information is required at this stage.

Should you require further information, please do not hesitate to contact me.

Ngā mihi
Hannah

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Web: http://www.massey.ac.nz/massey/research/research-ethics/research-ethics_home.cfm
Work hours: Monday – Thursday, 7.30am to 4.00 pm.