The Mechanics of Grammar: Theme and Rheme in Engineering Education (MOG TREE) Solution

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Abstract

Mastery of the English language for effective communication by Engineering Higher Degree by Research Students (EHDRS) is critical for progress in their highly challenging academic pursuits and future professional careers. These communication skills are especially critical for those for whom standard English is not their first language, who now comprise a significant percentage of contemporary Australian EHDR cohorts. As of 2017, some 20,000 international HDR students were enrolled in Australia, which constitutes around 32 per cent of the total HDR cohort (Australian Government DET 2017). Not only are students' written and oral skills assessed in English, but any language obstacles can impact on their ability to understand and communicate the often highly complicated technical curriculum of Engineering, and hence can severely undermine confidence and self-belief. Students who have excelled throughout their schooling can suddenly find themselves questioning their intellectual ability, if their language skills significantly impede their capacity to communicate and understand effectively. Furthermore, 80% of all engineering academic journals are written in English and often require a highly effective grasp of the language to read and fully comprehend the subject. This can be extremely daunting, considering the expectations on EHDRS to publish alongside the authors of the works they read as peers.

The problem that is being addressed is that of enabling positive, accelerated learning of academic engineering writing skills for postraduate engineering students, so that their language skills come to match their elevated engineering knowledge.

In order to help these students to achieve the requisite skills to become confident and self-directed researchers, this thesis takes a humanistic view of learning and teaching (MacDonald 2012; David 2015), which places the EHDRS at the very centre of the research; actively engaging them throughout the design and testing process. A key aim is to address the language and emotional issues underlying current attrition rates by accelerating EHDRS' (notably English as an Additional Language or Dialect (EAL/D) EHDRS') learning of nuanced, accurate academic English. Currently, HDRS undertake compulsory, generic genre level courses in academic writing but not explicit teaching at word, phrase and sentence levels, which would address their complex social, cultural and emotional needs. EAL/D HDRS regularly struggle to write fluently, and at speed, to a standard that meets supervisors' expectations.

This research is therefore designed to improve individualised discipline-specific learning, non-judgementally; to inspire the students' English language enquiry skills, emotional growth and resilience, taking a humanistic view of learning and teaching placing Mechanical Engineering higher degree by research students (EHDRS) at the centre of the research.

The thesis acknowledges the subliminal biases of English, using the Harkness paradigm to build an egalitarian, inherently positive learning architecture, both physically and philosophically and thereby taking a growth mindset position. The methodology is participative action research (PAR) (MacDonald 2012; David 2015),

which is designed to frame early research in emerging fields. Its iterative nature aligns with the engineering method.

The theoretical-linguistic elements of the research are framed by Lévi-Strauss' analogy of the engineer and the *bricoleur*, gifted and talented pedagogies, engineering modes of cognition and play theory. A detailed needs analysis was undertaken, along with short samples of written language for analysis of typical EHDR errors. Based on these analyses, playful, social language learning mechanisms were investigated to ensure a balance of knowledge and emotional capitals is achieved.

Subsequent to careful consideration of the learning mechanisms typical of engineering students (defined by the students themselves through the needs analysis and group discussion), a central aspect of the participative action research methodology was the development of an original, visual, kinaesthetic learning tool, which is focused on the Mechanics of Grammar, Theme and Rheme in Engineering Education, or MOG TREE. This appropriately-named, tactile learning tool physically resembles a tree and is supplemented by two other original language teaching methods for a tri-partite solution. It is social in nature, affirmatory, enables self-editing, and is industrial in design, ensuring that the learning system is appropriately adult. It is vital that the MOGTREE system is both conceptually and visually appropriate. The language tree elements derive from pedagogical traditions designed by Montessori and Cuisenaire-Gattagno. They are useful for planning, writing and editing in groups, language choices and punctuation selection. The playful nature of the language trees stimulates the EHDRS to generate lexical solutions by enabling sophisticated refinements without negativity.

The second aspect of the solution is the Mechanical Engineering corpus. It is designed to be used in conjunction with a concordancing tool. This is particularly useful for (b)EAL/D EHDRS, as it can give statistically verified answers to collocation questions, which are critical for developing natural language phrasing rather than L1-L2 direct translations (Sadeghi 2010), for example. The corpus can also be used alone, as a discipline-specific, academic phrase bank. The corpus, containing contemporary published Mechanical Engineering journal articles, can be both personalised and updated.

The third part of the solution is a grammar website (http://www.mogtreeapp.com). The grammar derives from the EHDRS' requests, as expressed through the needs analysis, with discipline-specific examples. The website works at word, phrase, sentence and genre levels, enabling fully-individualised learning pathways. It takes a pragmatic, settlement position in terms of traditional and systemic functional grammar terminology in order to be as inclusive as possible.

The results of the testing process show high broad agreement that the tri-partite MOG TREE solution is supportive, effective and engaging to use. The detailed results of the testing cycles are given. Potential applications and extensions of the research, beyond EHDRS' use, are suggested under "Future Research".

Statement of originality

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Abbreviations

AARE	Australian Association for Researchers in Education
ACED	Australian Council of Engineering Deans
AdTAT	Adelaide Text Analysis Tool
AGC	Adelaide Graduate Centre
ASD	Autistic Spectrum Disorder
b/EALD	Background English as an Additional Language/Dialect
BICS	Basic Interpersonal Communication Skills
CAD	Computer Aided Design
CARLA	Centre for Advanced Research on Language Acquisition
CaRST	Career and Researcher Skills Training
CAT	Computer Axial Tomography
CCSP	Common Core of the Structured Program
CSS	Cascading Style Sheets
CT	Collocation Tool
DMGT 2.0	Differentiated Model of Giftedness and Talent version 2
EA	Engineers Australia
EAL/D	English as an Additional Language/Dialect
EAP	English for Academic Purposes
ECMS	Engineering, Computing and Mathematical Sciences
(E)HDR(S)	(Engineering) Higher Degree by Research (Students)
ELF	English as a Lingua Franca
EMoC	Engineering Modes of Cognition
GT	Grammar Tool
HTML	HyperText Markup Language
IBP-R	International Bridging Program - Research
ICT	Information and Communication Technologies
IELTS	International English Language Testing System
IoS	Apple's Operating System
IoT	Internet of Things
IQ	Intelligence Quotient
L1	Language 1 (first language)
L2/3 +	Language 2/3+

MOG TREE System	Mechanics of Grammar: Theme and Rheme in Engineering Education
MRI	Magnetic Resonance Imaging
OED	Oxford English Dictionary
OPS	Optimising Problem Solving
OWLS	Older Wise Learners (PhD online Support Group)
PAR	Participative Action Research
PhD	Doctor of Philosophy
PTVS	Physical-Tactile, Visual-Spatial solution
RSD	Researcher Skills Development
SFL	Systemic Functional Linguistics
SME	School of Mechanical Engineering
SSE	Synergetic Systems Engineering
STEM	Science, Technology, Engineering and Mathematics
T1	Target Language 1
TER	Tertiary Entrance Rank
TG	Traditional Grammar
TIPD	Teachers' International Professional Development
UI	User Interface
USB	Universal Serial Bus
UX	User Experience
VAK	Visual Aural Kinaesthetic
VET	Vocational Education and Training
VR	Virtual Reality

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Chapter 1.
Framing the research

1.1 Introduction

English language skills are critically important for Engineering Higher Degree by Research students (EHDRS), with the challenges further exacerbated for international students, particularly those for whom English is not their first language. The numbers affected are significant, with over 565,975 international students enrolled in Australian education in June 2018, of whom over 50% are at university in higher education (Australian Government 2018). Furthermore, the majority of these are studying at postgraduate level. Their contribution to the Australian economy is also significant, at an estimated $140 billion in 2014 that rises annually. This leads directly to the employment of 120,000 full-time staff (Universities Australia 2018).

Covered in more detail later, Engineering is a particularly challenging discipline for these students, in which language difficulties impact on their ability to understand and communicate the often highly complex technical theories, which in turn can severely undermine confidence and hence lead to high attrition rates. Entry requirements into postgraduate engineering programs are high and so attract students who have generally excelled previously. However, the subtleties and nuances of the English language can suddenly lead to students questioning their abilities to succeed in their discipline of choice.

This early study of pedagogies and practices of nuanced academic language acquisition and use by engineering research students in the School of Mechanical Engineering at the University of Adelaide uses participative action research spirals

(Cohen, Manion & Morrison 2013) as detailed later to analyse the issues the students themselves perceive as accelerating or impeding language learning, then examines an experimental tri-partite solution.

The overarching paradigm is humanistic (Lakoff 1973) drawing together key educational knowledge of areas such as gifted education, engineering modes of cognition and play theory to create a new approach to learning and teaching of nuanced, academic English language skills for this very particular cohort.

The research covered in this thesis follows a humanistic sociolinguistics (Lakoff 1973) approach to examining the issue of how to support engineering higher degree by research students (EHDRS) in their academic writing development effectively. It examines how these particular students learn, their emotional and intellectual responses to language challenges and appropriate pedagogies for meeting their needs. It is also designed to support the EHDRS' supervisors, as it will save considerable time if the students' writing is more accurate and fluent, leaving time to assess their engineering skills alone.

The thesis enables the EHDRS to work from a position of strength, based on their identified language learning needs. It acknowledges that EHDRS are already successful learners and that their learning strategies can be harnessed in order to achieve success with language as well as engineering. The humanistic sociolinguistics approach also has an emotional component that supports active learning and gives ownership of the process and the outcome to this very particular group of learners. Practical, EHDR-orientated solutions are offered to and evaluated by the EHDRS.

The suite of elements that form the core of the language issues discovered through the needs analysis (Huddlestone & Pike 2016), are addressed by a tri-partite solution, where every element can work both independently and in harmony with the other parts, under the control of the EHDRS. The first solution is a physical-tactile, visual-spatial tool, called the language trees at Product level. It encourages drafting and reflective editing of structure, words, phrases, sentences and paragraphs. The second is a Mechanical Engineering corpus, which can be dropped into a concordancing tool and is particularly useful for EAL/D learners as it teaches collocations particularly effectively. The third solution is a grammar website, based around EHDRS' specific needs, is called http://www.mogtreeapp.com at Product level. Coupled with grammar workshops, this teaches the students control of the flow of language in academic engineering writing.

In the remainder of this chapter there is an analysis of the specific paradigms and understandings that underpin the thesis at a theoretical level. These approaches will be elaborated and explored throughout the research, which uses the participative action research model (Cohen, Manion & Morrison 2013). The model uses a spiral system to elicit feedback loops and then feed the new information into development through an iterative, adaptive, responsive approach.

The problem that is being addressed is that of enabling positive, accelerated learning of academic engineering writing for postgraduate engineering students, so that their language skills come to match their elevated engineering knowledge, thus a spiral approach is taken, using participative action research.

Spiral 1 (Figure 1.1) comprises the Discovery Workshops: the needs analysis and samples of writing. Throughout the three spirals, stakeholder review and feedback are constantly fed into the iterative experimental process. The hallmark of Spiral 1 is that it sets the parameters for the joint design of the tri-partite solution, all the elements of which are based on the needs analysis (Table 3.2 and Appendix 4) and writing samples (Tables 2.2, 3.3 and 3.4 and Appendix 5).

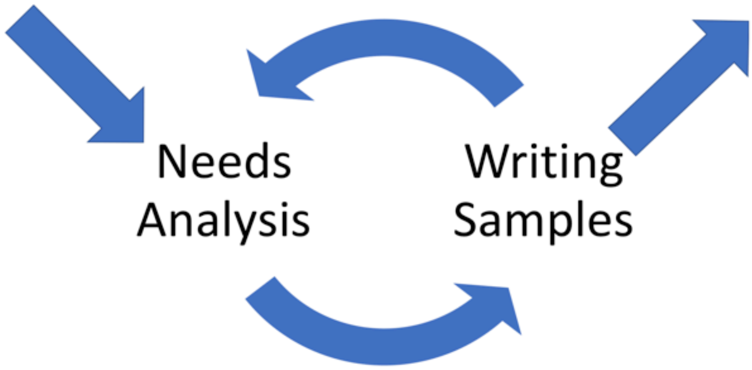


***Figure 1.1:** Spiral 1. The Discovery Workshops. The foundations of the MOG TREE system are based on the data in the needs analysis and writing samples*

Spiral 2, (Figure 1.2) comprises the Prototype Workshops, where the design of the tri-partite solution is explored in partnership with the EHDRS, based on the data from the Discovery Workshops. Student feedback remains critical, as the system, including its pedagogical aspects, continue to be evaluated and adapted. Participative action research is particularly suited to early research, which is politically and socially aware (Cohen, Manion & Morrison 2013), such as this project.

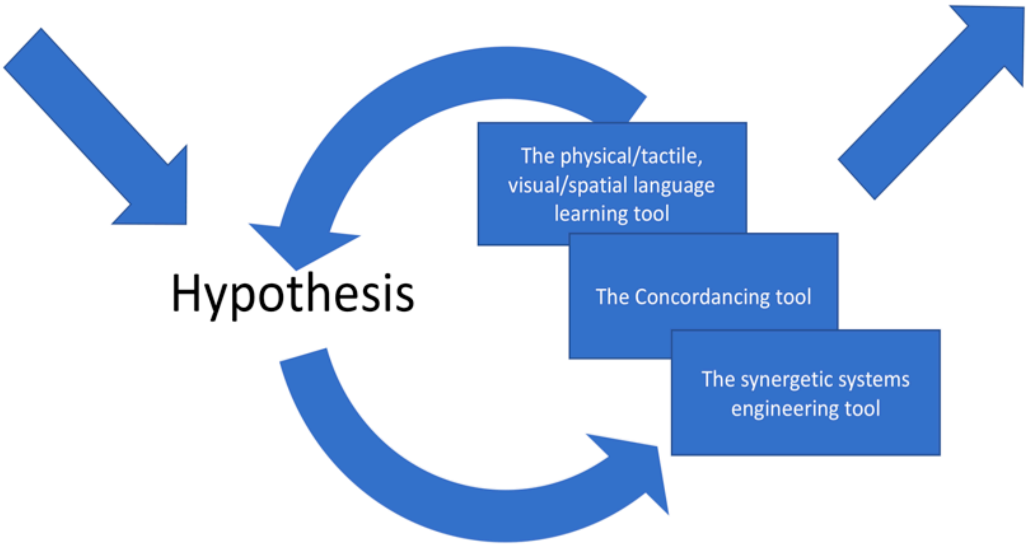


***Figure 1.2:** Spiral 2. The Prototype Workshops. The foundations of the tri-partite MOG TREE system are based on the data in the needs analysis and writing samples in Spiral 1*

Figure 1.3 gives an outline of how all three of the Spirals articulate together to frame the research and testing process.

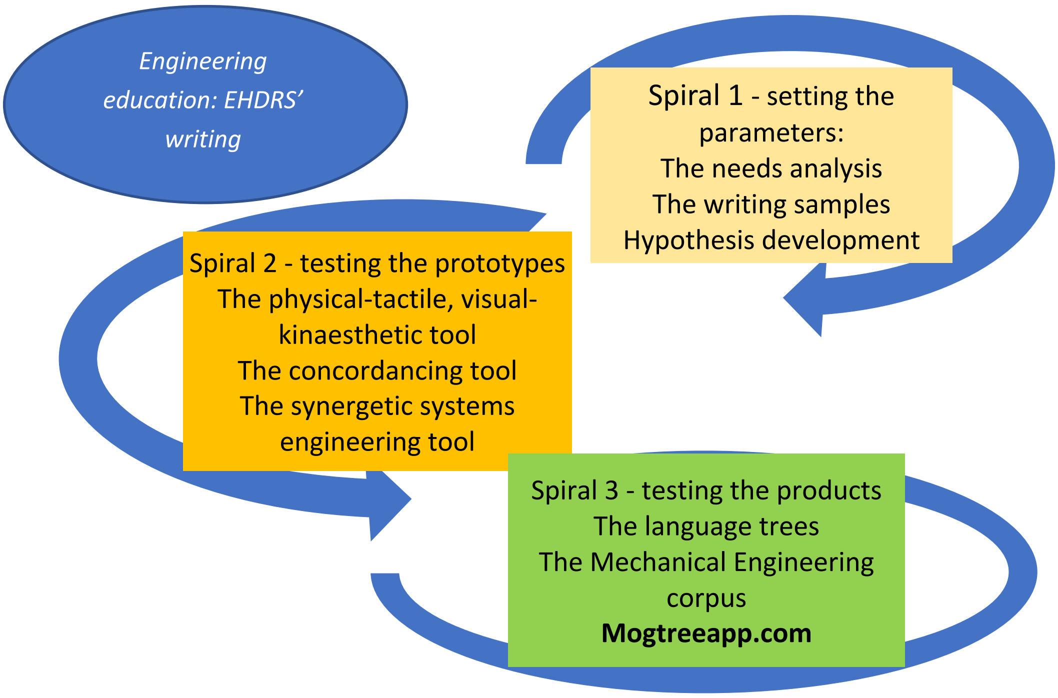


***Figure 1.3:** Spiral 3: The Product Workshop. The products are tested individually and as a whole, based on the findings of the Discovery and Prototype Workshops in Spiral 2 and the needs analysis and writing samples in Spiral 1*

A detailed outline of the participants in the spirals is given below (Tables 1.1 and 1.2).

Table 1.1: Cohort completing the Discovery and Prototype Workshops. N=16. (ECMS schools, gender, age and language backgrounds of the 16 participants in Spirals 1 and 2.)

University of Adelaide:	16	PhD:	16					
ECMS Schools:	Mechanical Engineering	13	Electrical Engineering	1	Petroleum	1	Computer Science/ Mechanical Engineering	1
Gender:	Male	15	Female	1	Other	0		
Age:	18-25	4	25-50	12	50+	0		
Language:	L1 English speaker	2	English as an Additional Language or Dialect speaker (EAL/D)	10	Background EAL/D	4		
Other language(s) spoken:	Greek (1)	Italian (3)	Persian (2)	Khmer (2)	Mandarin (5)	German (1)		

Table 1.2: Cohort completing the Product Testing Workshop. N=21. (ECMS schools, gender, age and language backgrounds of the 21 participants in Spiral 3.)

University of Adelaide:	21	PhD:	20	MPhil:	1			
ECMS Schools:	Mechanical Engineering	17	Electrical Engineering	1	Petroleum	2	Computer Science	1
Gender:	Male	16	Female	5	Other	0		
Age:	18-25	5	25-50	1	50+	1		
Language:	L1 English speaker	12	English as an Additional Language or Dialect speaker (EAL/D)	9	Background EAL/D	3		
Other language(s) spoken:	Bengali (1)	Spanish (1)	Vietnamese (2)	Persian (1)	Mandarin (3)	Malay (1)	Khmer (1)	German, Spanish, Romanian (1)
Prior achievements:	Taken other degrees at English-speaking universities (16)	Taken a Masters by Coursework at an English-speaking university (3)	Taken a Masters by Research at an English-speaking university (2)					

The overarching theoretical framework of the research focuses on humanistic sociolinguistics (Lakoff & Johnson 1980; Smolicz & Harris 1977; del Carmen Salazar 2013), offering unconditional respect for human agency and, therefore, an ethical approach to learning and teaching in specific contexts. Smolicz and Harris, Lakoff and Johnson, and Salazar (1977; 1980; and 2013) hold this value central to their work with diverse groups of social learners and model humanistic sociolinguistics throughout their research. This value-driven approach is visible as a key driver throughout the thesis and gives a pedagogical definition and robustness to the work as a whole, and the solution specifically.

Humanistic sociolinguistics focuses on the human-affective aspects of language, understanding language as a vibrant element of meaning-making that encompasses the cultural, ethical, psychological and transactional elements of human connections (Lakoff & Johnson 1980). This supports the research focus on emotional responses to learning, such as engagement, imposter syndrome and abundance. It also ensures that the intervention (learning) is effective, as it caters to affective as well as knowledge-driven needs, giving balance and logical reasons for the mode of delivery.

The broader humanistic movement encompasses a wide range of disciplines, focusing consistently on these values. Lakoff's seminal text *Humanistic Linguistics* (1973) defines the areas of interest for those involved in this paradigm as including the following elements: a) human reasoning; b) the examination of language to reveal the emotion underlying language (conscious or unconscious) which gives depth to surface meaning-making; the way language reveals personality or voice; c) the social interaction or transactional nature of language; and d) incorporating social, cultural and hegemonic norms that underlie the use and analysis of language for social justice in terms of political, legal and social reform.

This argument is strengthened by his second seminal text, *Metaphors we Live By* (Lakoff & Johnson 1980), which examines the interactions between experience, language and meaning-making. In this text Lakoff argues that teaching genre alone is insufficient for learners' needs, as meaning-making is shaped culturally. Thus, an evidence-based approach to language teaching and learning is necessary in order to support the EHDRS' particular needs, as it is acknowledged by students and teachers that "writing errors inspire negative judgments of both text quality and authors' characteristics" (Johnson, Wilson & Roscoe, 2017, P72).

Prior to this, from an historical perspective, a structuralist position was taken. Here, de Saussure (1959) and his followers saw language as a predictable science, where signs and their meanings have powerful, stable links through agreement. In this way, the signifier, or single unit of language, is stabilised when it enters a meaning system (Brabazon Vlog 90 2018). Human culture is treated like language: structured, predictable and meaningful. The limitation of structuralism is that works using binary oppositions. This leads to educative positions that are abundant or deficit, rather than supportive and growth-orientated.

Thus, in this thesis, a poststructuralist approach to language and teaching is taken (Lévi-Strauss 1966), whereby language is seen as a vibrant, growing focus of meaning-making. Under poststructuralism, meaning is seen as contingent and unstable, which matches the exploratory nature of this research. Meaning-making is found by considering the liminalities of meaning, that is, meaning is located in the silence or space between potential meanings, which contains the set of potential or other meanings. These meanings are in a violent relationship. Barthes (1967) is a seminal writer for the genesis of poststructuralism. He argued that authentic singular meanings of texts can no longer be accepted: that meaning lies with the reader and hence meaning is both unstable and multi-layered.

This matches with the core premises of this thesis: that there is no single way to teach language to individuals, with all their complexities, knowledge and cultural heritages. The solution, therefore, needs to be subtle, layered, flexible and supported by human contact. The research therefore recognises the tension between the need to learn English from a pragmatic perspective and the potential for offence given to other, devalued languages and cultures to achieve this pragmatic end. The thesis also acknowledges the emotional tension and violence that is part of language learning in context and therefore the emotional and political violence within this endeavour, which is concomitant with language learning and emergent meaning-making, are also addressed through the tri-partite solution.

Poststructuralism also supports the researcher's own voice, in balance with those of the participants. As meaning is derived from context and experience, all context and experience have crucial validity in the meaning-making process of this research, which is itself an original, creative journey of trans-disciplinary discovery.

In this way, the thesis takes an approach which balances such rules of language as there are, and then teaches EHDRS how to move from rules to meaning-making, which is a cultural, socio-affective shift in understanding. It is represented in practice in terms of the dual traditional grammar and systemic functional linguistics approaches, which are used for the purpose of moving between rule-giving and meaning-creating in the Mechanics of Grammar Theme and Rheme in Engineering Education (MOG TREE) website (http://www.mogtreeapp.com), thereby delivering an active settlement position in terms of the metalanguages and philosophies of grammar(s) (Pinker 2014).

The research itself is early research on an original topic, with original solutions tested and shaped by the stakeholders through the prototype workshops. It is qualitative in nature, using participative action research spirals to unfold answers. There will be more research needing to be completed in the light of this project and this is covered in Chapter 6. Although the thesis uses a form of experimental workshops, the findings will remain correlational (Salkind, 2012, p.7); that is, context dependent (that is: at the University of Adelaide, in the University of Adelaide School of Mechanical Engineering, led by this researcher) until proven otherwise by a longitudinal, broad based study across a series of institutions.

Implicit in this humanistic approach is the relevance of the voice of the researcher, which is an active and critical part of the research framework, articulating and valuing relevancy, appropriacy and respect. The following section contextualises this voice within the body of the research.

1.2 Scope

1.2.1 The Core Problem

At the heart of the problem lies the issue of how to enable EHDRS to achieve mastery of accurate, nuanced, academic English, whilst supporting their emotional engagement and confidence as learners. By engaging the EHDRS throughout the problem identification and solution generation process, the issues raised are owned by the EHDRS and the solutions flow logically from the needs identified by the EHDRS themselves. Prior to this research, this was not the case, resulting in inadequate language teaching for the EHDRS' needs. An evidence-based solution is an authentic need for this special group of language learners. The language acquired needs to flow, enable learning and publication outcomes, and fall within the boundaries of the requirements of postgraduate research in an English-speaking country; that is, to satisfy the regulatory requirements of journals and the graduate centres which manage theses.

Many of the postgraduates in Engineering are international students. Many (though not all) of whom speak EAL/D. Table 1.3 shows the numbers of international commencing students in all levels, particularly at postgraduate level, is significant and higher than that for domestic students. Thus, the numbers of students potentially experiencing significant issues with developing appropriate language skills are likely to be high.

Table 1.3: Numbers of Engineering students commencing degree programs in Australia in 2015. Please note that not all international students will be EAL/D and not all domestic students will be L1 English users. (Australian Council of Engineering Deans, 2017)

Types of students	**Numbers of students**
Domestic commencing students at Masters level	2,091
Total Domestic students at all levels	19,009
Domestic commencing HDR students PhD level	603
Domestic commencing HDR students at Masters level	108
International commencing students at Masters level	5,473
Total International students at all levels	12,365
International HDR students at PhD level	656
International commencing HDR students at Masters level	121

The latest government figures on completion rates show that "from 2010-2016, 437.030 domestic and international students enrolled in postgraduate research programs in Australian public universities. Only 65,101 completed within the same six year period" (Bednall in Conversation 2018). The same article suggests that a key element for success is "scheduling dedicated writing time, reframing difficult tasks as learning opportunities, and developing a work routine. This could be done as part of a workshop or supervisory relationship”. Furthermore, a second article (Chamberlain in Conversation 2016) suggests that “Supervisors have reported lacking the necessary time, confidence and skills to properly support their students’ writing… Large social events that normalise writing and collegiality are therefore attractive to early career academics”. Thus, the need for support with writing tasks and skills is recognised as a key element in success, which requires research-driven, targeted support in a focused, time-effective, social context.

Table 1.3 shows that commencing Masters students have achieved undergraduate, and in some cases even Masters level, postgraduate degrees in their first (or sometimes second) language and are therefore experts in their fields of Engineering. However, many are less confident, experienced and nuanced in their knowledge of academic English. Part of their learning journey forces the EHDRS to gain a clear understanding that their engineering knowledge will now be judged by their supervisors and peers for their mastery of the hegemonic, academic forms of English with which they are less familiar. Their supervisors in Engineering are often untrained in teaching English, time poor, and may have acquired biases about EAL/D students.

Without such linguistic skills, the EHDRS (with any kind of language issues from bEAL/D to EAL/D to those with language/functional challenges such as dyslexia) struggle to complete, leading to an elevated attrition rate. That said, the University of Adelaide has had an overall attrition rate of approximately 33% over five years (Jiranek 2010), whilst the national average is about 47%, after seven years (Martin et al 1999; Jiranek 2010). Indeed, the knowledge that they may well continue to struggle with any future career pathways where English is the dominant language of communication unless their language issues are addressed is a cause of high concern to many of the students. Participant 03's comment is typical of a number of such fears: "*We already can't get jobs to help us with living expenses because Australians are racist and say they can't understand our English. I worry about what will happen when I leave University. Will I get a job? Will I be able to publish reports without help?*" Lowering the HDR attrition rate is the basis on which the School of Mechanical Engineering justifies the economic cost of providing a language teacher for the EHDRS to support both the students and their supervisors; but this is not the foundation of the EAL/D EHDRS' fears.

Alongside this are the specific and more immediate needs of the School, Faculty and University. For EHDRS to graduate, they must communicate effectively in fluent, nuanced English. Supervisors generally, though not necessarily exclusively, supervise in English and most academic documents are written in English alone. So, there is a critical need for English to become familiar, controllable and effective across all four productive modes: speaking, listening, reading and writing.

As for the EHDRS themselves, their skills and originality in Engineering can become lost in translation, literally, if it is not transmitted effectively. Thus, the problem is central to Engineering Education and has corollaries in other Schools and Faculties.

1.2.2 The originality of the research

The originality of the work lies in the conceptualisation of a new, humanistic solution, designed for a particular cohort of EHDR language learners with a shared purpose, and its drawing together of a range of established approaches to learning and teaching to produce an original, cohesive, nuanced solution to a practical problem. This will also impact on the ability of their supervisors to use their own time and expertise wisely to ensure they can focus on engineering more than language learning issues.

In order to select those aspects of learning that best fit the issue of nuanced academic language learning, it is essential to outline the underlying core issues in the context of EHDRS at the University of Adelaide.

1.2.3 The thesis outline

Chapter 1 introduces the framework of the research: its elements, constraints and opportunities. It considers the scope, purpose and theoretical basis of the thesis as a whole. Chapter 2 presents the mechanics of the research: ethics clearance, the workshop context, practice architecture, theoretical frameworks and underlying pedagogical theories. Chapter 3 unfolds the Discovery Workshops: the needs analysis (Table 3.2 and Appendix 4) and writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) on which the solution(s) are predicated. This represents Spiral 1 of the research.

Chapter 4 evaluates the theoretical perspectives that drive the solution to the gap in our current knowledge, synthesising a range of knowledge capital in order to create a new solution. Here, the Prototype workshops are examined. The solution is tri-partite, and each element of the solution is examined, starting with the physical-tactile, visual-spatial solution, then the collocation tool, then finally the grammar website. Interim conclusions, decisions and product decisions are analysed. This completes Spiral 2 of the research.

Chapter 5 is an overview and evaluation of the system as a whole, through the Product workshop. Using mixed methods, the students' own voices are recorded to examine the potential of the solution when used by real EHDRS. This completes Spiral 3 of the research.

Chapter 6 considers the conclusions and opportunities for further refinements and ameliorations to the MOG TREE system, and future work.

Please note: All images are used with the consent of those within the photographs, as per the Ethics clearance.

1.3 Background

1.3.1 The voice of the researcher

The humanistic, analogous approaches to the totality of language, that is, of language as revelation of hegemony, cultural determination, and moral as well as communicative transactions, are a vital component of this thesis and a powerful driver of its originality. The research considers lived realities and layers of learning and need in context. Each of these elements also underlines the necessity for and validity of the researcher's voice within this research. For example, Reinharz (1992) and Rogoff (1998) argue that this is particularly valid for those voices which focus on the visibility of author identity in many of its forms as part of an intersectional, poststructuralist approach, which aligns with the cross-cultural, transdisciplinary aspects of this work.

The issue of identity (specifically that of the EHDRS) lies at the heart of this research. Thus, the research is not designed to teach language divorced from lived experience, but rather to engage with the human, cross-cultural, social reality of all the stakeholders in meaning-making in order to enable access for all the EHDRS to the dominant discourse of specifically engineering writing; using nuanced, accurate, academic English.

1.4 Background Literature

1.4.1 Reconceptualising gifted and talented education

Gifted and talented offers a strong framework for teaching highly able learners in a positive way, by harnessing the power of learning in different domains in an interactive fashion. It also leads to research-driven choices about modes of delivery of learning and teaching.

The conceptualisation of giftedness is a much-contested question and the parameters have been refined as recently as 01 December 2017 (K, 2017) in the light of revisions to the intelligence quotient (IQ) tests undertaken, notably to the ceilings of the subtests (Table 1.4).

Whilst an IQ test is only one aspect of testing for giftedness (typically such testing also involves an interview, social-emotional development, markers of resilience, assessment of prior achievements, and/or external testing for discipline-specific outcomes, notably in Music, for example), it is the most objective and most commonly recognised form of testing.

As per Table 1.4, the definitions of levels of giftedness are currently being lowered due to the ceilings generated by the newest tests (WISC-IV, SB-5 and WJ-III cognitive), so that 120-125 represents moderately gifted and 142-145+ for profoundly gifted, however the levels have yet to be set (K 2017). What the shift means is that IQ testing is perhaps less objective and empirical than has previously been acknowledged.

IQ testing also requires administration by a qualified psychologist, so IQ testing of the postgraduate cohort is beyond the scope of this thesis.

Table 1.4. Hoagie's Education Page: Current Definitions of Giftedness. (K, 2017)

Level of Giftedness	**Full Scale IQ score WISC-IV, WPPSI-III source: Assessment of Children**	**Extended IQ score WISC-IV source: Technical Report #7 WISC–IV Extended Norms and publisher's 2008 NAGC presentation**	**Full Scale IQ score SB-5 source: Gifted Minds Assessment & Counselling**	**Full Scale IQ score WISC-III, WPPSI-R, SB-4, SB L-M**
Gifted or moderately gifted (G or MG)	130-138	130-145	124-133	130 - 145 (132-148 SB-4)
Highly gifted (HG)	138-145	145-160	133-145	145 - 160 (148-164 SB-4)
Exceptionally gifted (EG)	145-152	160+	145+	160 - 180 (SB L-M only)
Profoundly gifted (PG)	152-160	175+	145++	180 and above (SB L-M only)

However, more holistically, there are markers of exceptional achievement recognised by universities that are deemed appropriate. In order to achieve entry to a postgraduate course, candidates must have achieved at least a Bachelor degree, usually with an Upper Second class/Distinction degree as a minimum and may well have published peer-reviewed research. Potential candidates also need support from potential supervisors, who will have discussed their proposal with them (University of Adelaide 2018). To achieve a high-level degree requires both academic intelligence and grit or resilience. These qualities will be needed throughout the postgraduate degree. Depending on the discipline, Bachelor degree entry level will also have required at least a reasonably high level of potential and achievement at secondary level, or some form of IQ or special tertiary admissions test (SATAC 2018).

It should be noted, however, that success in engineering study is not wholly dependent on prior achievement. McCarthy et al (2010 pp 9-10) demonstrate that the correlation between achievement at school and achievement in first year engineering courses is not powerful, so there are a multiplicity of elements to be considered.

Nonetheless, the background information developed above suggests that postgraduate students fall into at least the gifted/moderately gifted band, as defined in the table above, and may well fall into the higher ranges of giftedness. It is therefore logical to look to key tenets of gifted and talented education to start to build an appropriate pedagogy for the EHDRS, as per Gagné's DMGT 2.0 (2012) (Figure 1.4).

Gagné is one of the founders of gifted education. Interestingly he is also a bi-lingual *Québécois*, writing in English though naturally a speaker of Canadian French (Gagné 2012). In the light of this detail, and the vast body of knowledge about teaching in a bi-lingual environment extant in Canada, it can be argued that his approach is particularly empathetic in nature.

Gagné's DMGT 2.0 (2012) (Figure 1.4) is a solid foundation on which to build responses to language teaching for EHDRS, as it conceptualises learning at a theoretical level, breaking down the elements of learning into their component parts. Version 2.0 contains greater detail than the original version of the model. The DMGT 2.0 is also nuanced in that it recognises that not all humans have parallel abilities across all areas (that is, gifted and talented engineers may not simultaneously be gifted and talented linguists) and that the line from gift to talent may be challenging and complex. To enable this movement to occur, Gagné proposes groups of typical catalysts which trigger movement forward along the continuum from gift (potential) to talent (mastery of a named skill). This list is particularly fertile for humanistic pedagogy development, as the clarification enables the development of streamlined, catalyst-aligned features for praxis development.

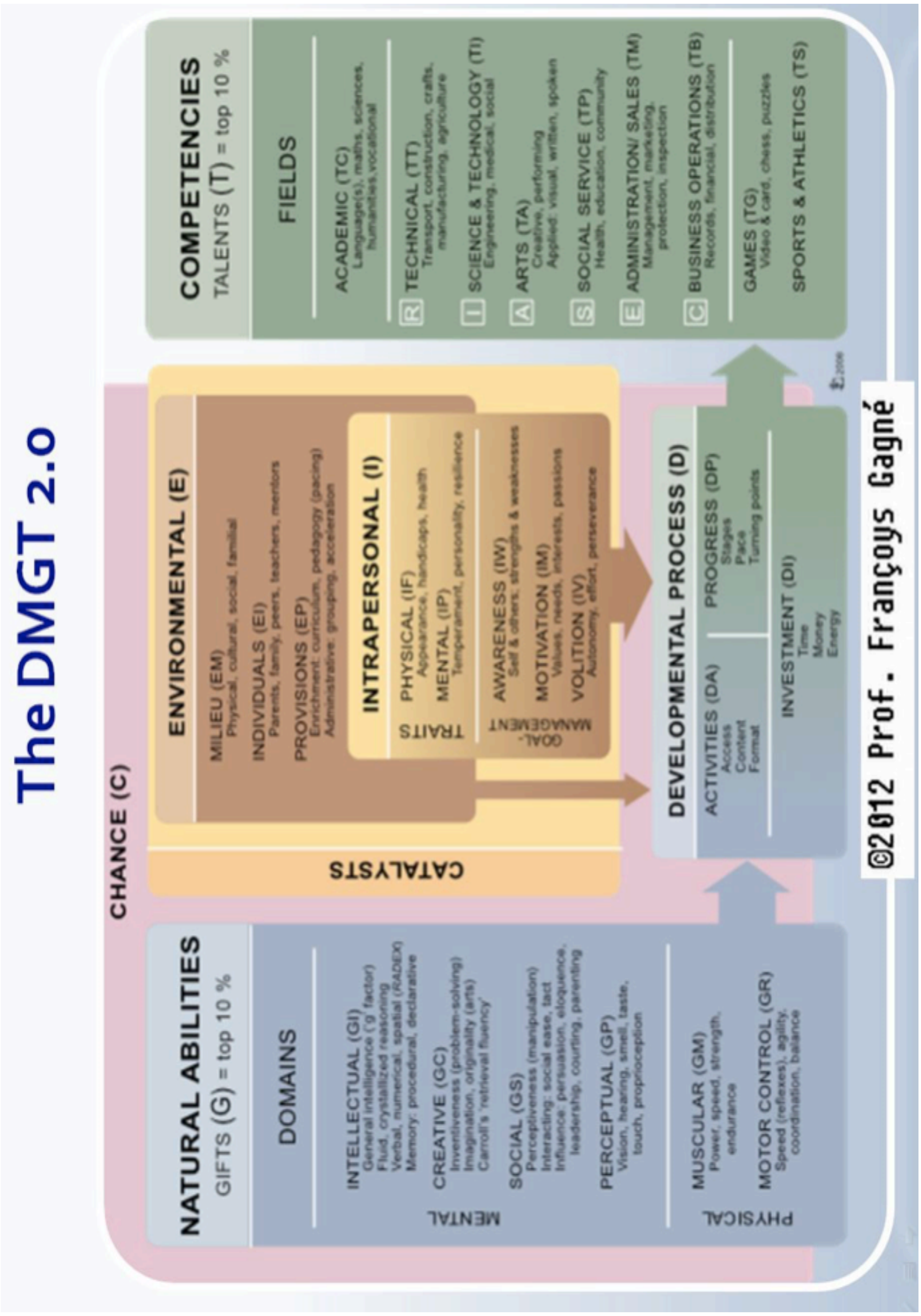


Figure 1.4: The Differentiated Model of Giftedness and Talent 2.0. (Gagné 2012)

The environmental catalysts in DMGT 2.0 (Figure 1.4) are external, personal catalysts, whereas the intrapersonal catalysts are internal or well-being orientated elements. By remaining conscious of both types of elements, it is possible to bring a humanistic element to the teaching that will significantly boost both the formulation and the efficacy of learning and teaching for this particular group of learners.

Whilst all the catalysts are vital, goal management contains critical catalysts for successful learning and aligns strongly with the Harkness approach, which values self-awareness, motivation and levels of volition. Here are the catalysts that can enable learners to create new "treasures" (del Carmen Salazar 2013), in harmony with and alongside the complex challenges of learning.

The natural abilities are also critical as they describe the need for highly conceptual approaches to learning (which align with the EMoCs). They also emphasise the need for sensory learning and link this with academic, creative and social learning and development.

In this way, the DMGT 2.0 (Figure 1.4) fully aligns with the needs recognised by the EHDRS themselves in the needs analysis (Table 3.2, Appendix 4), and so needed to be actively engineered into the proposed solution(s). This alignment of mind, physicality and sensory capacities was clearly essential for accelerated learning by these highly capable learners. Thus, there was a clear need to align the learning and teaching process with identified, familiar engineering modes of cognition.

1.4.2 Engineering modes of cognition

There are two major, opposing, schools of thought on EMoCs: one suggests that learning preferences are pre-determined and identifiable. Internationally, professional research and industry support groups like the Royal Academy of Engineering (Lucas et al. 2014) have proposed learning approaches that suit many engineers. These approaches are tactile, kinaesthetic, visual, spatial, problem-solving approaches and align with the nature of the subject. From this perspective, engineers are both born and developed. The Royal Academy of Engineering (Lucas, Hanson & Claxton 2016), (Figure 1.5) visualises the EMoC approach as a tri-partite, skills-based gearing system:

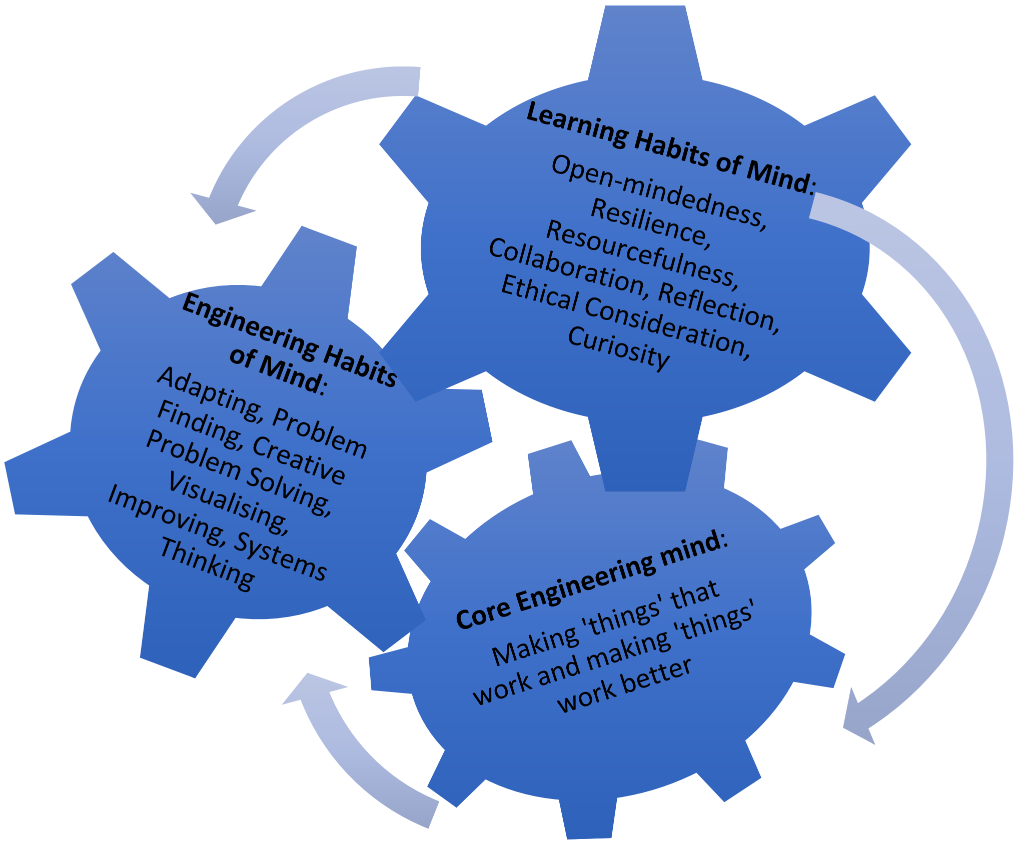


Figure 1.5: Engineering Modes of Cognition (Lucas, Hanson & Claxton 2014)

Conversely, neuroscientists like Westwell (2013) can find no organic evidence of this inherence. There is evidence, however, from computer axial tomography and magnetic resonance imaging scans, of what happens when a brain engages, or achieves flow (Csíkszentmihályi 2008). The more able the subject, the more clear the evidence becomes. Given the consistency of responses of engineers to particular types of stimuli, it would appear reasonable to suggest that if we tap into these common forms of stimuli and response, then a state of flow would be accelerated for many EHDRS, as the form of learning would be both comfortable and familiar. This supports a way of learning that incorporates not just language at a lexical level but also at an emotional and social level. EHDRS, therefore, could work around key issues such as imposter syndrome and avoid negative elements of Dabrowskian disintegration, whereby elements of self-efficacy have to be destroyed before they can be re-built in a new, more effective form (Pyryt 2008 in Mendaglio 2008).

It has been shown (Cope and Kalantzis 2008) that learning is achieved primarily through analogy or moving from the known to the new. By exploiting familiar modes of cognition in engineering learning, it should be possible to make language learning become more familiar as a process, thereby accelerating the learning. Engineering is a high-stakes, high entry-level discipline, and, therefore, attracts very able, successful learners. By making learning familiar and comfortable, it should be possible to support lexical and grammatical learning effectively. It works by avoiding some of the somatic exigencies (where the body reacts to the mind's emotional state), typically associated with gifted learners (Pfeiffer and Stocking 2000), which can lead to emotional distress, trauma or collapse. This is evident through imposter syndrome's impact on the attrition rate and indeed the levels of emotional hyper-stress I see regularly through my editing work at the university.

The analogy of the *bricoleur* can also be seen to underpin this approach, as it seeks to contextualise language learning within the discipline and within the realm of the familiar. Again, it lends itself to high stakes learning contexts and enables rather than setting up a deficit or remedial paradigm of learning.

Alongside the economic, real-world, global learning drivers coming from Industry 4 conceptualisations of learning and university research, EMoC research by professional bodies such as the Royal Academy of Engineering (Lucas et al. 2014) suggests that engineers are predominantly visual-spatial, physical-kinaesthetic learners, who actively engage in problem solving. This strongly aligns with the Gagné's (2012) vision of gifted learners (Figure 1.4). Other learners may well also display these qualities too; however, while every discipline has a set of recognisable, defined traits, engineers as a cohort are largely cohesive in learning and thinking style, which means that a cohesive solution is a reasonable expectation, reaffirming the need for a discipline-specific solution.

Whether the modes of cognition approach stems from an internalised pre-disposition to learning or whether is a taught and responded to as a result of a range of catalysts to learning (Gagné, 2012), is debatable. Certainly, the perception that EMoCs are fixed has been moot for some time (Bennet 2013). However, there remains a defined set of typical modes of learning, which is helpful, as it is familiar to the EHDRS themselves and can be acknowledged as a common starting point for educational research.

As early as 1990, Winsor drew attention to the need for both practical models and human teachers, rather than purely abstract chalk and talk pedagogy (Winsor 1990). Whilst her context is pedagogy, she also discusses modes of cognition implicitly and elucidates a need for physically sensory (visual, kinaesthetic) pedagogies. Bennet (2013) strongly attacks what he perceives as a blind faith in Visual Aural Kinaesthetic (VAK) learning styles, seeing it as an unproven, superficial approach to learning (for an example of this approach, see Swinburne 2016). However, although EMoCs use some of the language of the pure VAK approach, the concept is far more sophisticated and data-driven, based on typical modes of cognition and learning catalysts and as such, aligns far more closely with the reality of the teaching space. EMoCs also align with the notion of *bricolage* in that they offer a diverse range of learning solutions, rather than a single, simple, mono-dimensional approach. Diamond (2013) discusses the need for students to develop executive functions, such as problem solving, in order to deepen and control learning, yet even these executive functions are controlled by core functions: impulse inhibition, working memory and cognitive flexibility.

If, as seems clear, problem solving is a key function of engineering thinking (Figure 1.5), then it is reasonable to argue that the ability to engage with elements of engineering problem solving is taught and responded to at such a degree that the elements move from being catalysts to learning to being central to learning. Aligning any solution to the issue of accelerating language learning with such an approach, whether physically or, later, via virtual reality, should both catalyse and centralise language learning, accelerating it for the engineers involved in the program. A layered, nuanced approach should also return control of learning to the students, both showing them respect and engaging them to take active decisions in their learning, thereby enabling individuals to gain ownership of the problem-solution. By moving to a controlled impulse mode of learning, pedagogy moves into the realm of Industry 4.0 or post-industrial learning (Richardson, Abraham & Bond 2012), because ownership is gained through impulse control: that is, from pure *bricolage* (a utilitarian approach (Baker and Nelson 2005)) to an engineered solution.

Westwell (2013) is clear that the core issues of learning should be seen as based in neuro-science and then addressed through appropriate post-industrial pedagogy. If engineering, then, is seen as both a discipline and as having favoured discipline-specific pedagogies, by aligning with these pedagogies and learning habits, learning in all areas should be accelerated, encouraging flow (Csíkszentmihályi 2008), thereby deepening, supporting and accelerating the whole process.

Current approaches to pedagogies of language do not focus specifically on engineering modes of cognition, which means that teachers of language may well be asking for new, unfamiliar ways of learning which have no synergy with the students' current and historical successful learning methodologies. By aligning with the appropriate EMoC approaches to learning and teaching, any new system should be able to move students from the known to the new (Cope and Kalantzis 2009). Cohen and Levinthal (1990) propose that absorptive capacity is founded on what is already known and that this is particularly true for industrial research and development capacity. It is also a mechanism for embedding new learning in practice, which aligns with the search for integrated, research-driven drivers for learning, or catalysts. By using familiar ways of learning but in the alien context of learning about language (writing, social contexts of language and so forth), it is arguable that a new language learning system could also support EHDRS' socio-affective responses to learning and teaching (Peirce, 1995). This would simultaneously remove the palpable anxiety and tension within the student group and support active learning through the development of a social identity within this particular language learning, social context.

Indeed, there is significant evidence that the process described above is not only useful, but essential. Cohen and Levinthal (1990 p.128) argue that relating prior knowledge to new information and situations is vital for expanding human capacity. This is the firm's (in this case learner's) absorptive capacity: the process needed to support accelerated learning across fields of learning; or moving from the known to the new.

This is reinforced in terms of language learning by Immordino-Yang and Damasio (2011) from a neuroscience perspective, linking language learning, social functioning, memory and decision making, all of which are shown to be emotional responses to information. Thus, by analysing common approaches to learning in Engineering and replicating them through a novel language-learning system, it should be possible to accelerate deep language learning significantly at a range of levels. If this is coupled with social learning, the contextual learning will also be enhanced, supporting well-being.

1.4.3 Social learning

Social learning has already been discussed in terms of its validity for meaning-making. Peer-to-peer learning and group work are inherent in a range of tertiary Engineering courses (for example, the first year Professional Practice course, Mechanical Engineering course 1006, at the University of Adelaide) and as part of the development of professional team-work skills. Replicating this approach enables familiar public/social learning and takes some of the negativity out of learning as it is seen as part of the building of networks of information. The originator of the sentence in a group-work language-editing task still owns the knowledge but the details of developing the words, phrasing and punctuation are shared across the team, supportively. This is a familiar process of learning for engineers, and so will be a useful approach to take as part of the solution(s) to be devised.

In the next section, the concept of the importance of affect to learning will be discussed in terms of the reality of its impact on student mental health.

1.4.4 Cognitive dissonance/Imposter Syndrome

Cognitive dissonance (Encyclopaedia Britannica 2018; McLeod 2018), commonly subsumed into the term imposter syndrome, derives from the gap between self-perception and value, potential and outcomes (for example, writing of theses or journal articles). This dissonance can lead to feelings of powerlessness, paralysis and even suicidal ideation. Avoiding exacerbating this condition by creating and enhancing flow through socially supportive learning practices is clearly positive and is designed into the solution(s) resulting from the research. By taking a humanistic approach, the pedagogy and praxis articulate together to create not only avoidance of a remediation, but the development of a positive approach to learning and teaching and therefore circumvention of negative aspects of affect, or cognitive dissonance.

It has been clearly established that postgraduate students can suffer from insecurity in their self-belief and self-definition as learners, to the point that the term 'imposter syndrome' is commonly used for the spectrum of insecurities, from perfectionism to depression, which affect significant numbers of postgraduate students (Chapman 2017). Imposter syndrome was a term coined in 1978 by clinical psychologists Clance and Imes, defined as an emotional state leading to crippling fear and chronic inability to complete tasks (in Bernat 2008). Whilst this is not specific to EHDRS, the dichotomy between their skills in engineering and their control of writing is frequently the locus of EHDRS' insecurity or cognitive dissonance. This can then be compounded by an often-masculine environment in engineering faculties, where feelings are not typically openly discussed (de Pillis & de Pillis 2008). Indeed, the system of supervision means that the supervisor may well be unaware of their students' fears due to cultural barriers to openness such as 保面子 or *bao mianzi,* which means "to guard" or "to save face" to avoid perceived disgrace or humiliation (InternChina 2016). It is interesting that this phrase is itself an active verb, in the infinitive, reflecting how the emotions involved are themselves both active and seemingly infinite. Whilst this notion of saving face exists in European countries, in the Asian world the concept has even greater force and can be a significant driver to force issues underground, potentially resulting in failure to complete postgraduate studies and even leading to suicidal ideation in extreme circumstances.

For postgraduate students, therefore, the issue of language mastery is intrinsic to issues of emotional well-being as, despite the fact that the students may complete the IELTS or equivalent at postgraduate entry level, the language tests require general communicative competence, rather than mastery of the academic register. A register that is coupled with grammatical and lexical accuracy, translating knowledge of broad concepts into discipline-allied discourses, which therefore means that international postgraduate students in particular are often ill-prepared for the linguistic rigour of their courses. As Velautham and Picard (2009) affirm, it is the differences in genre and expectations that make access to appropriate, nuanced language so challenging. Indeed, when the rubric for Task 2 in the IELTS was compared with diverse university writing tasks (Moore & Morton 2005), the differences in the language skills sets were significant, as the IELTS relies on personal experience for source material, whereas academic writing requires a complex range of academic inter-textual relationships in a formalised, specialist framework. At genre level, IELTS relies on the essay format from a single source, whilst university engineering writing relies on expositional writing from multiple, often contradictory sources, which is significantly different. Müller (2015) suggests that the differences in error rates across the critical band levels 5, 6 and 7 are sufficient to create alienation between students and supervisors at bands 5 and 6. By band 7, the error types tend to converge more closely with L1 speakers of

English and thus are found less emotive. The identification and amelioration of EAL/D issues, therefore, is urgent and pressing from school level upwards as they are visibly and literally critical to success.

The reality is that, alongside the culture shock from living in a new society with its particular socio-cultural paradigms, language skills are a significant inhibitor of progress and learning. EAL/D students in particular need more time to complete all reading, processing and responding to tasks as they struggle with lexical, grammatical and syntactical issues, as well as cultural discourse and presentation norms. As Cummings (2010) demonstrates, by examining the length of time required to achieve age-appropriate levels of language proficiency, it is observable that EAL/D students need a significantly greater amount of time to achieve parity with their L1 English speaking peers: time which is not built into their academic program or milestone achievement timings.

Conversational parity for EAL/D learners takes an additional two years, whilst academic proficiency parity takes between five and seven years (Cummings 2010), which is hugely significant given that PhDs are expected to take between three and five years to complete. These significant roadblocks to learning, particularly when coupled with symptoms of imposter syndrome such as perfectionism, can lead to huge damage to learners' self-esteem and self-efficacy.

An interesting and lively debate focuses on the methodology for describing and delivering language learning: that is, the extent to which technical terms should be used to outline grammatical and other relationships between and across elements of language. Schleppegrell (2013) suggests that there is good evidence that using "meaningful metalanguage" (p. 153) supports accelerated language learning for L2+ English language learning.

1.4.5 Developing a meta-language for meaning-making

As has been argued, the cultural aspect of learning and teaching is essential, as language does not operate in a vacuum. The signifiers or individual lexical items of language systems represent concepts (the signified), rather than having any concrete or absolute connection with those concepts (Halliday 2012). English as a language is particularly difficult to master as it is itself a polyglot, analogous language (Crystal 2007; Deutscher 2011). As a result, the English language is layered into formal and informal lexical items and phrases (primarily Latinate in the former case and Germanic in the latter), which is confusing enough, particularly for those of a non-European background, The difference between very spoken and very written language is often the very difference between the tested communicative competence and the university required nuanced academic English (Lakoff & Johnson 1980; Halliday 2012).

In order to teach language effectively and succinctly, it is necessary to have a shared meta-language of language terms and conceptualisations. Thus, the solution(s) incorporate technical descriptions of language as a short-hand for teaching language rules. These are taught explicitly at the point of need, not to obfuscate with complex technical terms but to clarify through the use of necessary terminology or naming of things. This simultaneously shows respect to the EDHRS, as there is an implicit assumption they are more than capable of learning this new meta-language and absorbing it into their repertoire of approaches, giving them ownership of the meta-language of language.

In this way, the pedagogical approach taps into the key notions of learning readiness, which can be defined as the nexus of a student seeking knowledge and being willing to change their learning behaviour (Euromed Info 2017). In particular, they go beyond the confines of traditional English for academic purposes practices (Bruce 2008; Fenton Smith & Humphreys 2015) or systemic functional linguistics (Fries & Gregory 1995), into a multi-faceted approach or *bricolage* (Lévi-Strauss 1966), which can then be engineered to operate as a bank of carefully designed, focused learning possibilities to support language learning at an individual level for engineers, acknowledging the cultural, hierarchical and pedagogical impediments to learning and seeking to work around them to produce harmonious resolutions (Lucas, Hanson & Claxton 2014). In this way, to paraphrase Mambrol (2016), the linguist becomes an engineer of signs: a craftsman who deals with projects in their entirety, taking into account the availability of materials, and creating new tools in conjunction with the postgraduate students; offering them a new, more appropriate *bricolage* from which to engineer their language skills positively and with confidence. Another method for making this learning of signs more engaging is to include playfulness in the social aspect of learning: this is the focus of the following section.

1.4.6 Playfulness

There were various forms of resistance to language learning to be found amongst both international and local EHDRS in the needs analysis (Table 3.2, Appendix 4) and writing samples (Tables 2.2, 3.3, 3.4, Appendix 5), Spiral 1 Discovery Workshops. This resistence has also been noted in a series of earlier studies, such as Jones 2001. The issue of emotional security is significant, as discussed earlier, but the issue of emotional accessibility is also relevant. This goes beyond a simple instruction to turn on a computer in order to give physical distance to the learning: it focuses on the self-constructed narratives by which we understand living paradigms (Brabazon 2016).

Thus, play theory is highly relevant here as it promotes Vygotskian (1978) flow (translated from the Russian: течь): the writing equivalent of the literary notion of suspension of disbelief, enabling students to literally take time out and work on a necessary element in a non-threatening way. It can be argued that play offers the freedom to synthesise, create and originate ideas. This very adult definition of play as the essence of creativity and the formulation of self, beyond self-efficacy, locates play at the heart of any solution to the issue of accelerated learning. It also makes a solution based on play an adult solution, not a reversion to childlikeness. This distinction is crucial in making the concept palatable to the adult learner: a form of catalyst and energiser of learning.

Sicart (2014; in Brabazon 2016, p.3) defines play as "a form of understanding what surrounds us and who we are and a way of engaging with others": that is, it builds confident, social learning that boosts both creativity and hence deep learning. It is also a way of managing risk: raising the stakes whilst lowering the risk of failure in a high cost, high stakes environment. Wong and Logan, (in Brabazon (ed) 2016, p.12) define play (points, 2, 5, and 6), as:

- "Stimulating, and actively engaging: play requires either physical, verbal or mental engagement with materials, people, ideas or the environment."
- "Non-literal/Symbolic: play is often pretend, it has a 'what if' quality. The play has meaning to the player that is often not evident to those outside the play."
- "Process rather [than] product oriented."

Each element aligns strongly with the traits of EHDRS' preferred EMoCs and ways of learning: play is inherently sensory, analogical and problem-solving. As such, it can be argued that introducing elements of play deepens learning, enabling the player/learner to engage in non-threatening, familiar learning patterns that break the cycle of fear that undermines most language learning for many postgraduates who are experiencing cognitive dissonance and exclusion from an environment in which they have previously been successful. Wong and Logan (in Brabazon 2016, p.17) argue further that this is the link with the ideas of learning by Piaget (1976) and the notion of flow developed by Vygotsky (1978), which link play and socio-cultural learning theory: a theory which is demonstrably linked with language learning, as language is culturally embedded. Vygotsky (1978) explicitly claims that "the relationship of play to development should be compared to the relationship between instruction and development... play is a source of development and creates the zone of proximal development".

McArdle et al. (in Brabazon 2016, p.38) also link the notion of *bricolage*, as they see the co-joining of play and *bricolage* as processes that enable learners to go beyond the superficial into nuances of learning: exactly the focus of this level of language learning. *Bricolage* enables the teacher to show the student how to uncover "the invisible artefacts of power and culture" (Kincheloe et al., in Sumsion et al. 2009, p.168). This aligns with the notion of English for academic purposes language teaching operating at one level as a form of cultural imperialism, unlike English as a *Lingua Franca*, which is owned by a defined community, is often oral or informal in nature, organic and open to interpretation and meanings that inherently invoke a diverse and open range of cultural imperatives and experiences that are made invisible and, indeed, denied by the more "accurate" English for academic purposes.

If, however, English for academic purposes can be seen as enabling of access to power through re-presentation and the addition of accuracy at lexical level as well as genre level, then it becomes more engaging as it becomes controlled by the user, rather than being a negative gatekeeper per se. To take this notion of the positive nature of play one step further, referencing Freire (1970, p.80, cited by Charko et al., in Brabazon 2016, p. 58) Charko et al claim: "Dialogue cannot be carried on in a climate of hopelessness. If the dialoguers expect nothing to come of their efforts, their encounters will be empty, sterile, bureaucratic and tedious." This is clearly visible amongst the postgraduate community: where the EHDRS feel excluded, marginalised and criticised by constant reference to their weakness in language control, they stop attending language classes and avoid situations that disenfranchise, demotivate and destroy their sense of self-efficacy and well-being. If a new pedagogy can be devised that encourages, that sees the positives, building on the knowns and linking those knowns to the new, thereby avoiding the common deficit pedagogies currently extant, locating language issues as one part of the necessary learning, which can be learnt successfully using known, successful strategies, then engagement will be lifted significantly.

Digital technologies, which allow for invisible drafting and almost infinite information flow, offer ever greater scope for positive, dynamic approaches to language learning, as has already been suggested. It has already been argued that physical, tactile learning is an essential part of learning, specifically for engineers, who practice problem-solving using these skills.

It should also be clear that new language learning pedagogies need to be nuanced themselves, offering a range of pathways into the solution for each given learning issue. Digital technologies clearly play a significant part in the nuancing of learning and teaching in a modern postgraduate world, though it can equally be argued that they are, like all simplistic, mono-directional methods, insufficient by themselves without human contact and powerful theoretical boundaries. Brabazon (2016, p.123) notes that digital technologies offer five key pathways into learning by providing: 1) a framework for the presentation of learning materials 2) a space for the construction of the interaction between learner and an information environment 3) a matrix of communication between learners and teachers 4) a matrix of communication between learners and learners and 5) a matrix of communication between teachers and learners. This gatekeeping facility (the flow of information across and towards learners in a structured manner) is crucial and enables learning to go beyond a classroom situation: a mode of learning required for the trainee researcher or postgraduate student in order to enable them to move into full independence.

However, to increase engagement, a human environment is still needed. This human environment can be provided within the digital world, through the provision of sonic media elements that enhance the connection and empathy automatically removed by using screen alone. Simultaneously, such humanistic aspects also add to the depth of learning experienced by widening the sensory experience. Each time the learning is made interactive rather than imposed, it becomes socially embedded, giving the learning authenticity and individual nuance. Thus, the new praxis must include a range of approaches in its *bricolage* or utilitarian approach (Baker & Nelson 2005), and it is echoed in typical engineering postgraduate student approaches to language editing which typically involve multiple iterations, based on whatever resources are available. so that solutions can be engineered along individual pathways to engineered new knowledge and deep understanding. Harris and Daley (2007, quoted by Reid and Wood in Brabazon 2016) support this view, arguing that play enhances the social capital of adult learners by making new learning devoid of stigma, enabling nuancing of newly processed information and broadening the spectrum of knowledge available to the learner.

1.4.7 Drivers of the research

In order to contextualise the pivotal value attached to effective academic writing in English, it is crucial to recognise that some 80% of all academic journals are written in English, with all 50 of the top-ranking journals published in English in the United States of America or the United Kingdom (Huttner-Koros 2015). Publishing in a language other than English will not necessarily advance a career, particularly in the English-speaking world, nor will it ensure the same widespread access as the new knowledge contained in articles published in English. Thus, the academic hegemony of English language publishing, wherein (for the Australian context at least) the metrics are selected and imposed by Euro-centric, English language speakers (SAGE Publishing 2018; Wiley 2017) can lead to denial of access to nuanced, accurate, academic English if it is not taught explicitly. Such denial of access simultaneously blocks access to powerful, potentially career-enhancing publishing opportunities.

There are also significant charges attached to commercial English language services. For example, SAGE publishing (SAGE Publications 2018) offer standard and premium packages costing some $537 USD [as at 31 May 2018] for a six-day workaround, and explicitly state:

> *"Disclaimer: Please note that SAGE Language Services is an editing service only and using the service will in no way guarantee that your manuscript will be selected for peer review or accepted for publication. Journal editors independently assess manuscripts submitted for publication based on the quality*

> *and appropriateness of a manuscript for the journal, and their editorial evaluation will not consider whether or not a manuscript has been edited through SAGE Language Services." (2018)*

The Premium package is the only one that claims:

> *"Premium Editing will improve syntax, style, and flow in addition to correcting spelling, grammar, usage, and punctuation errors. Premium Editing also includes a summary sheet outlining the changes made to the document and suggesting additional revisions. Our Editors will change improper language and suggest alternate phrasing when poor wording is used. Each Premium Editing will receive a SAGE Language Services Editing Certificate thanks to our rigorous quality control." (2018)*

This is a significant charge for editing services which offer no guarantee of publication success. In some instances, this cost is added to the cost of publishing accepted papers by some journals. Thus, there is an economic imperative to teach accurate, nuanced, academic language, effectively and efficiently, to EHDRS who need access to publication in high quality journals and a successful thesis written in English. This is an important driver, addressing the need for inclusivity and empowerment of all EHDRS not only as students but also as future researchers.

The language needed by international engineering students at Australian universities is both oral and written, as the ideas are developed and evaluated orally under supervision conditions, as well as transmitted through writing. As such, conversational English is required in a very specialised form, more aligned with the structures of writing than natural speech or colloquial English (Bruce 2008 p.95). Bruce (2008, p.98) summarises the *gestalt* or metaphor approach to language as: "*gestalts* (image schemata) in the cognitive genre model relate to the most general, overall organisation of ideas, but not to the actual arrangement of written discourse". Thus, at macro level, teaching through authentic texts is a critical part of modelling language, recognised widely in EAL/D teaching as "read-to-write integrated tasks" (Li 2016 p.73), and this element is drawn into the eventual solution both for reading and writing. That is, the writing samples (Appendix 5) invite the students to write abstracts about their own research, making the exercise a pure writing task and not a research-plus-writing task and in-class tasks are authentic learning tasks.

Authentic texts are an integral part of English for academic purposes, as the work is focused on authentic examples of real, published genres, (unlike many EAL/D texts which use limited, targeted vocabulary and structured variations of syntax, for example, and are thus termed created-texts). The current research suggests that to find authentic texts and tasks which are examined at micro level (that is, at word, phrase, sentence and paragraph level) is essential in order to support the detailed academic language development of EHDRS.

Whilst framing of meaning-making can be taught to an extent through the use of stock phrases (for example, through the use of the Manchester Academic Phrasebank (Morley n.d.), this is not sufficient (Bruce 2008, p.109). Transmission of new discipline-specific knowledge requires a highly refined paradigm, connoted through the language choices made, which reflect and shape the knowledge in terms of its own discipline (Bruce 2008 p.134). This meaning-making skill needs to be part of the knowledge capital of the individual EHDR, hence the need for an individualised set of pathways for developing these high-level skills.

In order to achieve knowledge capital, it is necessary to consider relevant paradigms and pedagogies in order to match and align the learning and teaching processes. Achieving this requires consideration of a range of aspects of learning, which, when aligned, should engender engaged, accelerated learning that is emotionally supportive, mitigating the fierceness perceived through the poststructuralist lens.

The originality of the current research is two-fold. It lies in its examination of the gap: the need for effective teaching of authentic academic English meaning-making in a research-based, tri-partite solution. This solution draws together both a poststructuralist perception of language as a violent paradigm and the emotional needs of the EHDRS through a unique delivery system based on threads of pedagogical research taken from a range of aligned sources.

1.4.8 Paradigms and pedagogies

The underlying position of this thesis, that humanistic pedagogies of language learning are an imperative in the global, English-language-based transaction of knowledge, has a range of implications. First of all, the subjects of the study (the EHDRS, with their modes of cognition and emotional complexities, whether innate or developed through their undergraduate training) are at the heart of every aspect of the research.

Whilst this need is particularly obvious for EAL/D students, it is also necessary, albeit to a more limited extent, for Language 1 (L1) speakers of English, who are more familiar with the High School level range of registers and genres of English, and access the information more quickly, as they are not translating each concept and word. However, even the L1 students may not have complete facility with nuanced, academic English. This is a levelling process, so that both EAL/D and L1 English speakers have parallel access to appropriate language control. After all, EHDRS who come from overseas may be successful Language 2+ (L2+) English language learners, yet unfamiliar with the discipline-specific, nuanced, academic English required for EHDRS by their time-poor engineering supervisors.

The research is discipline-specific in its focus. Thus, the research engages with ways of learning that are typically displayed by this particular cohort, with their particular dynamics of identity as the key contextual elements. The intersection of the voices of the students, their supervisors and the researcher, therefore, plays a pivotal role in this research.

By learning about the needs of the humans, the project defines and explores ways to accelerate the learning process by taking what is known about how engineers learn, the engineering modes of cognition (EMoCs) (Engineers Australia 2014), play theory (Brabazon 2016), how postgraduates learn, termed gifted and talented education approaches, notably the catalysts delineated in Gagné's *Differentiated Model of Giftedness and Talent* (DMGT) 2.0 (2012) (Figure 1.4), in terms of their emotional state and what the students themselves perceive as their needs through a needs analysis (Table 3.2 and Appendix 4). These elements are then aligned with an analysis of their writing samples (Tables 2.2, 3.3, 3.4, Appendix 5). This theoretical knowledge of learning and teaching is merged with the EHDRS' own needs analysis and the analysis of their own writing samples to become the foundation from which is created a positive solution for all EHDR learners of nuanced, academic, accurate engineering language. Figure 1.6 presents a schematic of the overarching theoretical positions taken throughout the thesis, which lead into the solution.

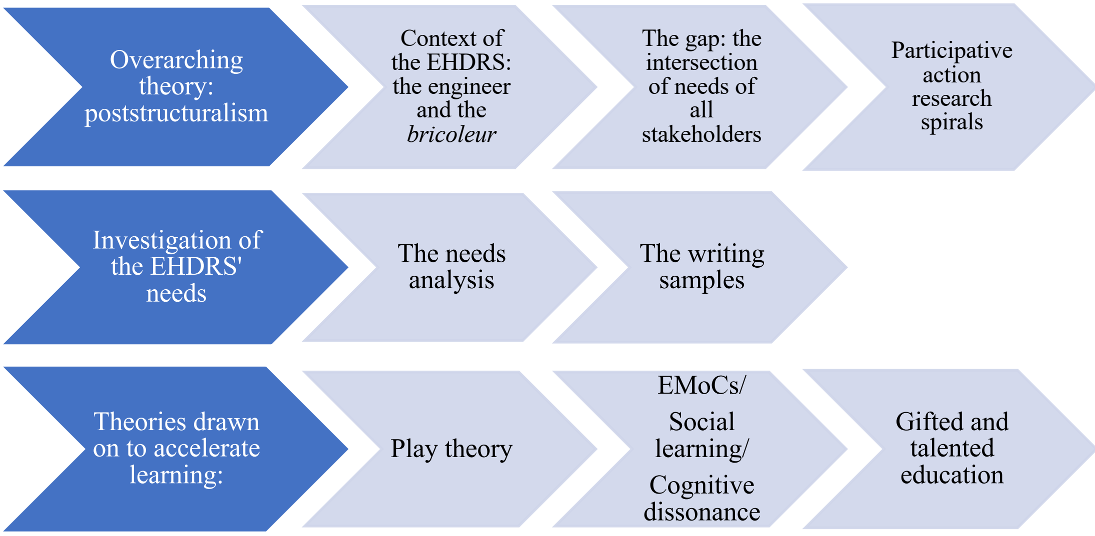


Figure 1.6: The over-arching theoretical positions underlying the thesis and leading to the solution: each of the individual layers feeds information and theory into each element of the solution

Furthermore, the solution needs to address both practical writing and emotional needs, for example, using the Centre for Advanced Research on Language Acquisition (CARLA) (Cohen & Oxford 2001) paradigm; an amalgamation of affective and cognitive learning approaches for tertiary level engineers. This paradigm not only demonstrates a clear humanistic vision but also offers a robust framework to pedagogy that answers Hu's plea (Hu 2016 p.327) for "researcher-learner inter-subjective understanding". This process involves deep listening and analysis of learners' needs followed by action to support these needs, which is clearly transmitted to and agreed with by the learners. Hu argues that this both sharpens the shape of the pedagogy and offers originality at design as well as experimental level for the methodological and pedagogical framework of the experiment.

Indeed, contextually, it has been hypothesised that engineering education is an emergent, post-modern discipline with transdisciplinary elements (Folauhola et al 2009). It can also be argued that whilst it is starting to fulfil Folauhola et al's (2009) request for shaping and sharpening of its implicit and explicit paradigms into one cohesive, distinctive, legitimate paradigm, accompanied by its own emerging forms of knowledge capital, engineering education remains a new, slightly fragmented, inter/trans-disciplinary field, seeking its own meaning-making as part of, yet distinct from, both Engineering and Education, without, Folauhola et al. argue (2009), having yet secured this paradigm. Thus, as Engineering Education emerges to become gradually more formally recognised as a discipline, building its own academic paradigm (Mann 2006), a new set of integrated approaches to the discipline-specific socialisation of language use is also emerging, notably in writing. It builds dynamic, fresh solutions to the specific language issues of engineering postgraduate students. In order to be fully integrated with traditional grammar and systemic functional linguistics content instruction to create a blended transdisciplinary whole, the solutions need to be both distinct from, yet in dialogue with, broader ways of knowing, learning and teaching, as current pedagogies and approaches, whilst useful, are insufficient, particularly for EAL/D students.

Current academic writing teaching (for both L1 speakers of English and background (b) EAL/D postgraduate students) primarily focuses on genre and corpus levels, with some structural, sentence level work, defined by Swales as genre and rhetorical moves (Swales 1990; Paltridge and Starfield 2016 p.12). The work is effective in many ways and offers critical help in terms of analysing move sequences within text types (Swales 1990; Hyland & Bondi 2006; Thompson and Diani 2015). Nevertheless, the genre-based framework tends to be didactic rather than responsive in nature: it offers analysis of current writing and trains the less experienced postgraduate writers to fit into the genre. It is not sufficient at word, phrase and (to an extent) sentence level because it does not deal with those levels specifically and discretely unless they align with genre needs (for example, signposting, organisational syntax or types of sentences to fulfil genre needs). Thus, writing can be well-argued from a logic perspective (Swales 1990) and well-framed at genre level, yet remain so inaccurate at word, phrase and sentence level that meaning-making fails (Winsor 1990). This can induce trauma in diligent, previously successful learners of parallel disciplines, such as engineering.

A critical aspect of supporting the EHDRS is that the research will examine both learning and teaching, and pedagogy, from both delivery and reception perspectives, in order to mediate these twin needs and support the humans through a careful practice architecture, which acknowledges the cultural, emotional and social aspects of language learning (Hill 2003; Goodyear, Casey & Kirk 2016). In order to achieve this, the thesis examines the expectations of the gatekeepers, or those who either enable or prohibit formal academic progression through a series of academic milestones, as mandated by individual university graduate centres (here, the Adelaide Graduate Centre 2017b), to formulate an optimised, individualised, human centric pedagogy. Such gatekeeping comprises a number of elements; thus Figure 1.7 shows a synergetic systems approach to training (Huddlestone & Pike 2016), with feedback moving across and between every element. The specific topic of the needs analysis is located across the Analysis and Design (in this thesis termed Discovery and Prototype) sections, with critical decisions regarding cost- and time-benefits falling at the Design/Prototype workshops by engaging the EHDRS from the earliest point, starting with the specific question in the needs analysis (Huddlestone & Pike 2016). A needs analysis defines the parameters of the task and uses a synergetic systems approach (Figure 1.2) to develop solutions, a practice which articulates strongly with the participative action research model.

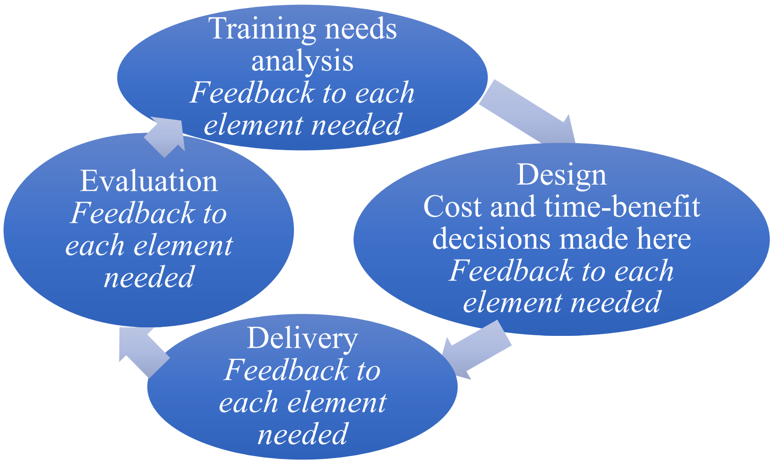


Figure 1.7: A systems approach to training (based on Huddlestone and Pike 2016)

For this research, the fundamental, open-ended question for the needs analysis (Table 3.2, Appendix 4) is: "*What do you need?*". The practice architecture (del Carmen Salazar 2013) of the work is designed to engage the students themselves through their agency and ownership of the materials that will be developed.

The tri-partite solution articulates with the key points of the needs analysis (Table 3.2, Appendix 4) and comprises a physical-tactile, visual-kinaesthetic tool, a concordancing tool and a synergetic systems engineering tool. In a sense, the system works in a perpetual present, embedded yet constantly revisited as the EHDRS shift, change and modify through their cultural context, specific learning needs and engagement with the system.

Figure 1.8 shows the Shannon Weaver Mathematical Model (1949, cited in Dowling, Carew and Hadgraft, 2013, p. 210), which is a key early model of gatekeeping practice. This early model of communication is the basis for the more sophisticated models developed more recently and discussed below, however it clearly reveals the core process of transmission and the stages of interference. In the Shannon-Weaver Model of Communication, the transmission process is linear, with noise as the intervention(s) preventing meaning-making:

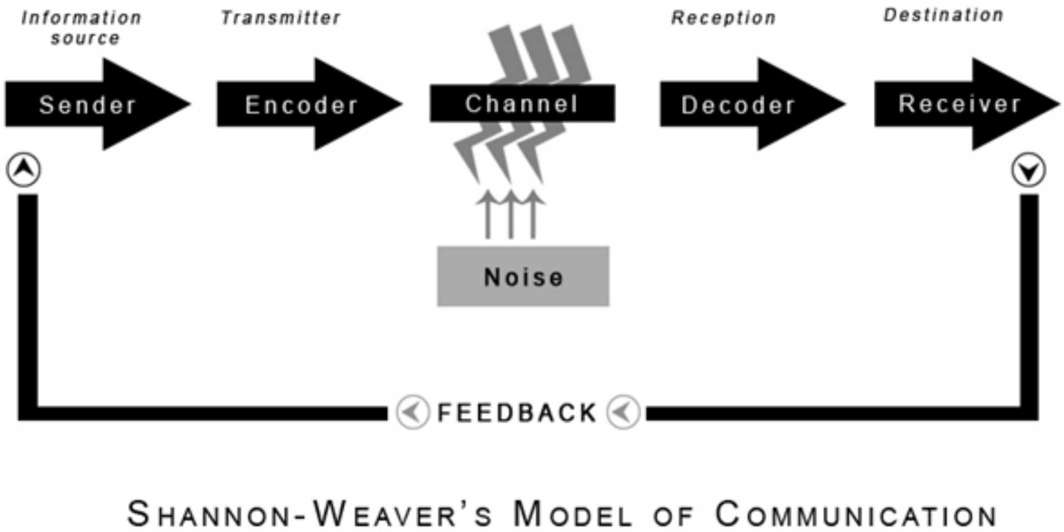


Figure 1.8: The Shannon Weaver Mathematical Model: an early model of meaning transmission showing the impact of noise or disruption between the encoder and decoder on meaning-making (Shannon-Weaver 2011)

A more contemporary, refined model is Foulger's (2004) Ecological Model of Communication shown in Figure 1.9. The model shows a more flexible approach to meaning-making wherein the creation of meaning is more unstable and multifaceted, relying on a complex system of shifting transactions, each of which can produce noise or interference.

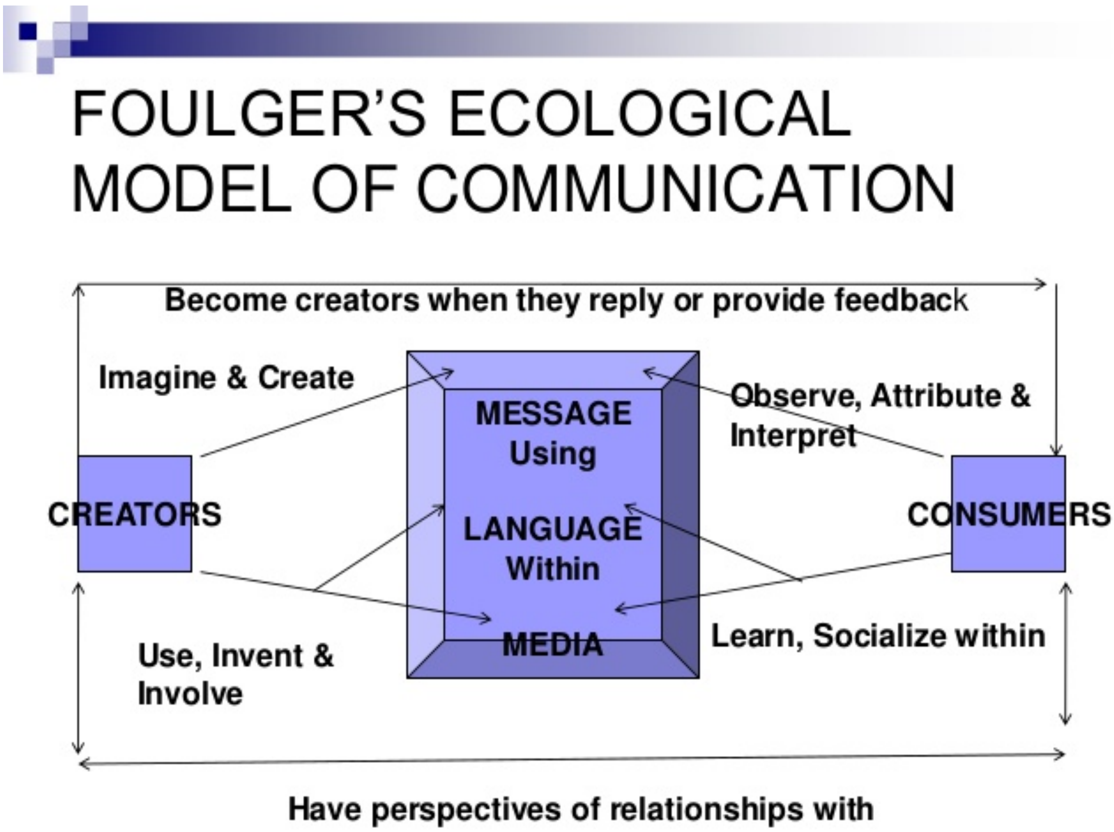


Figure 1.9: Foulger's transactional model (2004), revealing the complexity and flexibility of meaning-making

For many international EHDRS, it is language itself ("language within"), which is the critical preventer, or noise in the process of meaning-making or meaning-transmission. This humanistic research sees meaning-making in a circular, unfolding pattern, whereby meaning transmission is achieved over time in an iterative, upwardly spiralling fashion.

There is also discussion of the hegemony of English as a cultural as well as a linguistic practice, as this part of the emotional response to language learning in the EHDRS. This was an issue raised by the group during the semi-structured workshop interviews.

Other drivers include the desire for quick fixes or patches, overlaps of social/cultural/linguistic issues and issues of identity. The issue of using supervisor time wisely is also addressed. These elements will form a brief but important element of the decision-making process for the tri-partite solution (the physical-spatial, visual-kinaesthetic, concordancing and systems engineering tools) and re-emerge in a number of the design and pedagogical considerations for elements of the positive solution.

The over-arching theoretical analogy, therefore, is that of the engineer and the *bricoleur* (Lévi-Strauss 1966) as these powerful twin images reflect ways of thinking (here termed engineering modes of cognition or EMoCs) that can be used to engineer a positive solution or set of solutions to a critical gap in our praxis as learners and teachers. Lévi-Strauss (1966) argues that the engineer is the creator; the thinker who moves beyond the established norm. Meanwhile the *bricoleur* is constrained by the social-cultural norms and therefore works within the socially acceptable paradigm (Lentricchia 1980). Thus, this research aims to enable the EHDRS to move beyond their current partial successes, constrained by a partially successful set of learnings, into the innovation of the engineer: to be original, creative and successful in new paradigms and pedagogies of learning.

Thus, the proposed, original tri-partite solution is designed and tested with all the factors identified in the needs analysis and writing analysis in mind to identify and utilise effective ways of learning that are aligned with the discipline of Engineering's practice in order to enable the EHDRS to own and control the necessary knowledge capital (in this case, nuanced, accurate, academic English) and therefore gain the skills they need to create successful, original academic discourse.

The analogies, or *succedaneum*, work visually (in the physical form of the language trees, as well as metaphorically in the highly conceptual language trees referenced by the logo for http://www.mogtreeapp.com) for this cohort of postgraduate engineers.

Analogies are commonly accepted as being critical ways of learning for engineers (Burleson Consulting 2017). Analogies enable engineers to consider the covert values underlying engineering processes of all forms and enable them not only to be original, ethical thinkers but servant leaders of their communities (Robinson 1998). Indeed, this process can be described as a form of cognitive apprenticeship, leading to discursive identity (Craig, Lerner & Myer 2008). This fundamental conceptualisation is referenced across all three parts of the tri-partite solution to give coherence, encouraging use of all three parts as an holistic solution, as well as offering familiarity when one part only is selected for a particular solution instance.

The process of delivery of a set of practical solutions to the question: *"How can I optimise language learning for postgraduate engineers in a way that is familiar, accelerated and respectful of their abilities?"* is an engineering process: specifically, synergetic systems engineering (Pohl 2010).

The synergy of the solution is driven by its research method, participative action research spirals (Cohen, Manion & Morrison 2013), coupled with participative action research's iterative reflection to, of and from the needs analysis (Table 3.2, Appendix 4), research foundation and the experimentation undertaken to demonstrate its levels of efficacy. This methodology, coupled with the humanistic elements of the research, ensures that the twin academic discipline drivers of Engineering and Education are fully engaged throughout the work. The synergetic aspects of participative action research spiral use are indicated in Figure 1.10. Spiral 1: the Discovery Workshops cover the gap analysis, needs analysis and writing samples feed into the design of the solution. The designs are tested in the subsequent workshops: Spiral 2: the Prototype Workshops and Spiral 3: the Product Workshops.

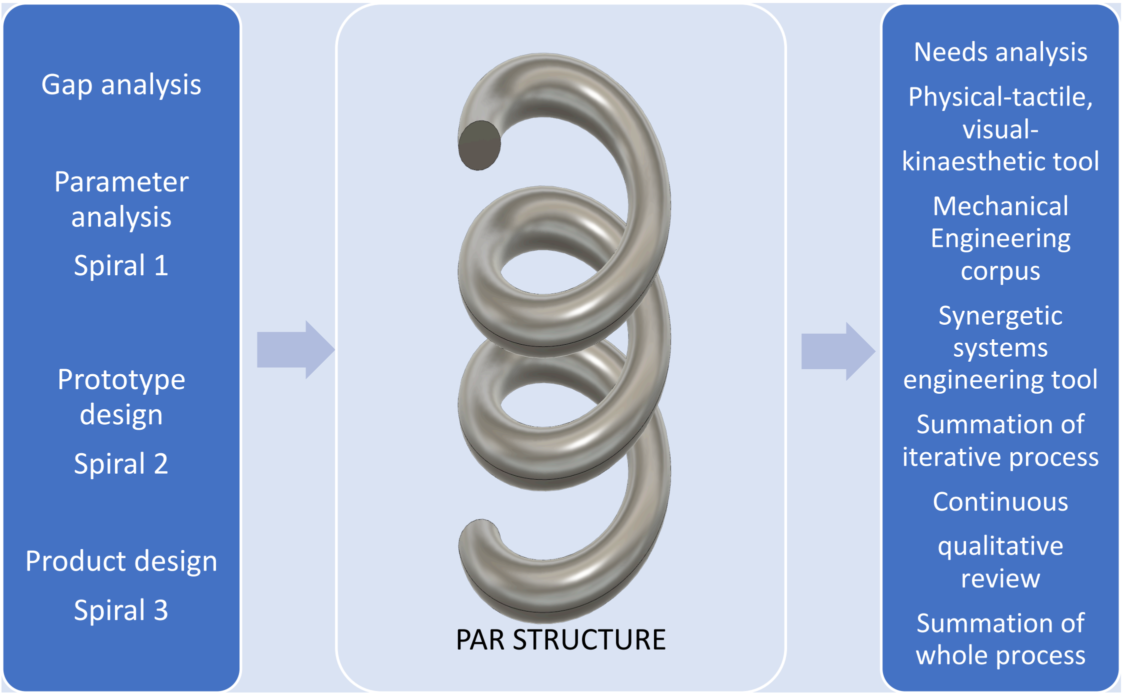


Figure 1.10: Schematic of the iterative process of participative action research spirals (based on Cohen, Manion & Morrison 2013)

Whilst the research draws on extant theories of learning, it draws key theories: play theory, gifted and talented education, engineering modes of cognition, cognitive dissonance and social learning together in a very specific way, deriving from the specific language learning needs identified by the EHDRS in the needs analysis (Table 3.2, Appendix 4). They are also demonstrated through the writing samples, which are the baseline writings (Appendix 5), revealing the error types commonly made by EHDRS (Tables 2.2, 3.3, 3.4).

1.4.9 Benchmarking against current practice

Current solutions for this issue predominantly fall into the field of English for academic purposes. English for academic purposes has a number of subfields, including EAL/D. Dyson (2016) suggests that a genre-based approach can significantly outperform an EAL/D pathways approach in her study of 171 primarily postgraduate students who were being prepared for university study in Australia. There are, however, caveats: for example, discipline specific language learning is acknowledged as a key issue in language learning (Benzie 2011). The other key issue raised is the level of language mastery at entry. The International English language testing service (IELTS) is the primary provider of testing for language scales, accepted by a wide range of Australian government agencies (IELTS 2014). There are two forms of the test: academic and general. The tests are rigorous, and the students find it hard to achieve the highest levels. However, the levels provide evidence of competence in conversational, general English, rather than HDR-level, academic English. So, even students with reasonable scores in the IELTS have not necessarily been trained in the skills they will need to become an effective researcher in a particular university discipline or sub-discipline. Thus, there is an inherent mis-alignment between the tests and the reality of the type and level of work required by the universities.

The genre-based learning approach is often more applicable for those with lower IELTS scores (Dyson 2016), suggesting that the approach needs to be varied for those at Group of Eight universities, for example, which typically ask for higher IELTS test scores on application for entry.

That said, the University of Adelaide, along with other Group of Eight universities in Australia, offers a limited range of pathways, or EAL/D approaches, to many of those students accepted on the strength of test scores during their first year of candidature, suggesting that a pathway approach is still invoked. At the University of Adelaide, the pathway for international students is the Integrated Bridging Program – Research (IBP-R) (Adelaide Graduate Centre 2017c). However, anecdotal complaints consistently arise from the students and their supervisors that academic language (notably discipline-specific academic language) is still an issue. Whilst there are a few more supporting strategies are in place, including payment for editing (proof reading) (Adelaide Graduate Centre 2017e), genre-based learning courses, and even English language courses such as those used for preparing students for the upper echelons of the IELTS tests, through on-going researcher training courses (Adelaide Graduate Centre 2017a). Leopold (2011) shows that focussing on discipline-specific language is essential and a wide range of English supports this approach for academic purposes researchers (Nguyen, Trimarchi & Williams 2012; Cargill & O'Connor 2013; Goldman et al. 2016). Thus, the University of Adelaide offers an inclusive, non-discipline specific Integrated Bridging Program – Research (IBP-R) course (Adelaide Graduate Centre 2017c). The School of Mechanical Engineering, recognising the refinements required for discipline-specific language learning, offers courses through the career and researcher skills training (CaRST) programme (Adelaide Graduate Centre 2017a).

However, the evidence shows that there remains a need for a coherent practice architecture (Goodyear, Casey & Kirk 2016) of learning and teaching of language, which is discipline-specific, needs-driven and emotionally supportive (that is, humanistic in the broadest sense) for this particular cohort of learners. This need for a coherent practice architecture is reinforced through the needs analysis (Table 3.2, Appendix 4) in this research and addressed through the solution generation, see Figure 1.11 for an illustration.

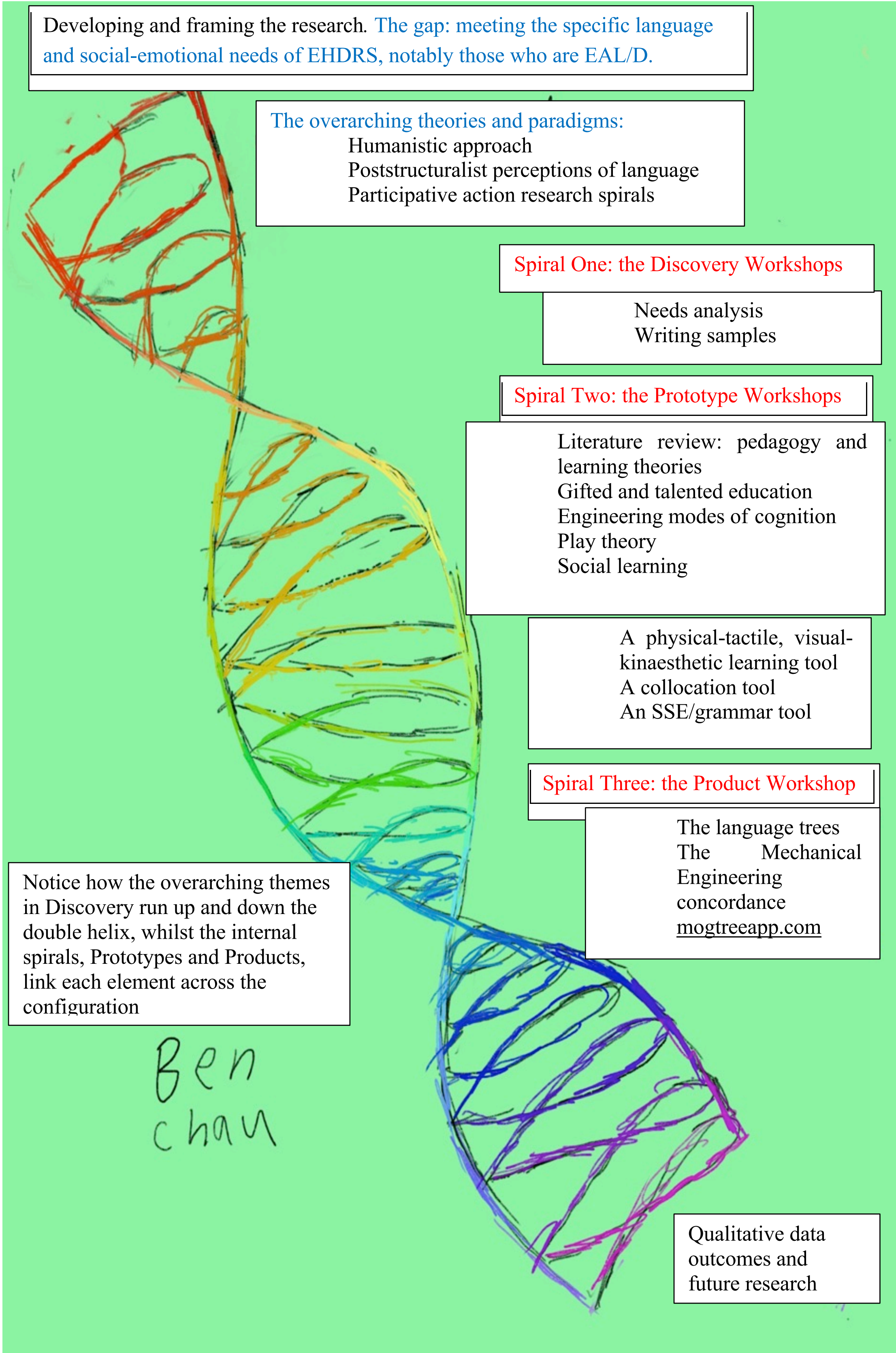


Figure 1.11: A draft outline of the thesis, showing the flow and interconnections across the spirals.

(Drawing by Ben Chau, Dara School, Adelaide.)

There is therefore a clear need to support EHDRS to learn sufficiently fluent, nuanced and accurate English to enable them to complete all aspects of their studies, from written to oral communication. Developing the ability to write in accurate, fluent, nuanced English for journal papers, conference papers and presentations and the thesis itself is key to their successful completion of their candidature. Australian universities generally require Level 6.5 in IELTS in Writing (along with a minimum of 5 in other areas) prior to commencement of candidature (Adelaide Graduate Centre 2017d; University of Melbourne 2017). Although a certain level of English, as tested primarily through the IELTS (2017) in the case of international students, is required for entry to postgraduate courses, IELTS and its equivalents test for communicative competence overall rather than academic accuracy in writing. This can leave EHDRS lacking mastery of nuanced, accurate, discipline-specific academic English. It can also leave EAL/D students and their supervisors with serious time issues.

Whilst writing programs are in place in many universities (e.g. Adelaide Graduate Centre 2017c), they are usually not discipline-specific, are often short in duration and delivered in a large group situation. They also tend to focus on a genre-based approach. This is important as the next stage in development for L1 English speakers and has been well-researched, with a number of evidence-based programs now embedded in whole university postgraduate preparation programs (Adelaide Graduate Centre 2017a). However, this English for academic purposes approach neither teaches, nor indeed encompasses, accuracy at word, phrase and sentence level and, as such, is not sufficient for the needs of all postgraduate students, notably bEAL/D and EAL/D. There remain significant pressures on students and their supervisors to improve writing accuracy, often without a safe, discipline-specific language learning context being made available for them.

With the rising numbers of EAL/D students in postgraduate programs in English speaking countries (Australian Bureau of Statistics 2013; Australian Council of Engineering Deans 2017) (Table 1.3), it is likely that EHDRS move into their original first language social groups and so miss the opportunity to mix with L1 speakers of English on a regular, consistent basis. This differentiation between learning social and academic language can be, but is not necessarily, reflected in university second language English courses, which can either be context-embedded, that is, general English, or context-reduced, that is, more abstract, language learning (Shing & Tam 2011). A context-embedded course is useful for integration into an English-speaking environment, however, a content-reduced one may be more useful for academic English purposes. Without discipline-specific context, its use is still limited for academic purposes. Furthermore, as many postgraduate students are older, they often move to the new country with their families. Having their families with them means that they have emotional support for their studies, but no target language (T2) requirement. Use of their primary language (L1) at home is usual.

Whilst these approaches involve some of the necessary elements for language learning, none addresses the humanistic element that the EHDRS are already experienced and highly successful learners of engineering. By aligning with this familiar Engineering way of learning, the MOG TREE tri-partite solution can significantly enhance learning in a targeted, effective manner.

It has also been demonstrated that it takes five to seven years for new migrants to America to match L1 speakers' proficiency in academic English (Arkoudis & Starfield 2007, p. 13). There is no reason to suggest that a similar timeframe would not apply in

Australia. Given that EHDRS have 3–4.5 years to produce a thesis in formal, academic English, this timeframe is extremely challenging.

Ultimately, the EAL/D EHDRS spend significant hours reading and writing in a language, engineering English, with which they may be scarcely more familiar than their undergraduate counterparts. While they do have support from their peers, they may also be un(der)confident and potentially inexperienced in the target language. The slow pace of language development is frustrating as a process and can lead to significant criticism of the student by supervisors who may not understand the significant additional hours required by an EAL/D learner to produce a written document of a similar standard as an L1 EHDR. Such a reaction damages confidence and self-efficacy and can have a significant impact on student well-being. In April 2017, the Australian (Hare 2017) reported that 50% of all PhD students identified as having mental health issues: a level twice as high as for the rest of the highly-educated population.

Supervisors can also become frustrated at the apparent inability of many EHDRS to make progress in (Australian) English writing accuracy despite living in an English-speaking country and spend many hours editing writing when they should actually focus on content and discipline-specific elements of the thesis or article. This can trigger significant emotional and academic tension between the student and their supervisory panel. In this way, the cultural and social impact of language, as delivered in good faith and with evidence that it is appropriate for local students, is an active and significant gatekeeper, which blocks or enhances both achievement in the research and positivity in the supervisor/supervisee relationship. In practice, ironically, it often operates as a deficit model, with negative social, emotional and academic outcomes.

At IELTS level 6.5, the required entry point of English language competence for postgraduate study in many Australian universities (Adelaide Graduate Centre 2017d), many international researchers have been working in a form of English known as English as a *lingua franca* (ELF) for some years (Holmes & Dervin 2016). Such a form and type of communication can be both successful and appropriate at an international level, notably via social collaborations, for example via social media and in online communities of practice where a more spoken form of language is sufficient. However, non-standard English is not accepted as a form of written language by most of the academic gatekeepers in charge of reviewing writing for publication.

A positive aspect of ELF is that it enables speakers to incorporate cultural, social and grammatical elements of their first language into their narrative, without deviation and without obstruction of core meaning. This is the diaspora of learning in action. After all, part of the collaborative drive of online narratives and dialogue is the intention to convey meaning and be understood across borders. Incorporating cultural, social and grammatical elements of their first language (L1) into the target language (T1) enables speakers not only to increase fluency, but also to enhance meaning as the language used strongly reflects a diverse range of meanings beyond the literal. It does this by carrying poetic, mythical or other elements of cultural understandings alongside the academic research narrative, enabling the research to fit into the broader social and cultural context of the speaker/writer. When such a writer is then introduced to the strict confines of purely academic writing and required to demonstrate mastery of it, there are a number of underlying assumptions in that superficially simple requirement which can create both trauma and significant resistance. However, a student who is only fluent in ELF, and not standard English, is further disempowered (Swan 2012; Widdowson 2013).

The key IELTS level 7 descriptors, which are 0.5 higher than required by many Graduate Centres and the level required for Permanent Residency, do not match the academic language requirements outlined above. The IELTS tests for communicative competence: that is, it operates at the level of general understanding and accepting minor errors (British Council 2017). Until a user reaches at least Band 8, complexity of language control is not sought under test conditions.

In summary, in terms of the IELTS and its equivalents, there is no focus on academic writing, let alone that which is discipline-specific. EHDRS at the beginning of their candidature, who have achieved level 7 (and many achieve this only at the end of their candidature as they seek to change their visa type), are skilled in engineering and have passed the test required by the requisite graduate centre, but now are asked to operate with nuanced, high level, accurate, academic English. The inevitable outcome of this is vast numbers of corrections made to their work, potential and actual rejection of research completed, and a significant waste of supervisory time on accuracy issues rather than engineering conceptual development. All of these factors can easily lead to a failure to complete.

A wide range of research shows that completion rates need to improve. The national government body, the Australian Association for Research in Education (AARE) (Bourke et al 2004) data, for example, suggests that only 51% of PhD candidates finish in four years and 70% in six years. Australian candidatures are predicated on a three to four and a half year research timeframe, with all financial support ceasing at this point.

It can be argued that the university has a moral duty to offer appropriate language support where they accept fees from international and EAL/D students and that a more focused screening process must take place before international and EAL/D students arrive. Instead, much blame is placed on discipline-specific staff who are untrained as linguists, instead of supporting students and academics by adding more formal layers of academic language learning and teaching. Academic research is global in nature and that means language skills should no longer remain a barrier to success.

EHDRS and their supervisors have a very particular and hierarchical relationship. However friendly, a supervisor ultimately has the power to move their students through a research program with their scholarship intact or deny their progress. This means that the student is obliged to filter their thinking, research outcomes and writing through the gatekeeping of the supervisor, who represents and is responsible to the administrative gatekeepers, the graduate centres, who are themselves beholden to government requirements. This significantly intensifies the hierarchical nature of the supervisor-supervisee relationship.

The hierarchical power relationship and denial of (a very limited definition of) success in the target language articulated alongside the issues of engineering learning and teaching and operate as a form of linguistic (hence also social and cultural) imperialism. This is a context in which the student can feel significant resistance and stress. It can lead, ironically, to EHDRS refusing the very offers of help with language learning they request, as the elements of power in the relationship may lead to feelings of inadequacy, infantilisation and a lack of motivation or fear. (The Language Workshops in Mechanical Engineering, for example, are attended by approximately one third of the EHDR population.)

These feelings of oppression are not necessarily or even frequently intentional on the part of a supervisor. A supervisor may well be delivering the necessary information to enable the student to achieve their studies with the required rigour (AQF 9 (Masters level) and AQF 10 (PhD level) Appendix 1) (TEQSA 2015).

It is therefore important to examine the complex hierarchies and perceptions of language in context in order to build evidence-based forms of testing, pedagogy and outcomes for the research, so as to try and balance the obligations on the gatekeepers to academic success, without undermining the students' well-being.

1.4.10 Meeting the expectations of stakeholders

A system of nuanced, emotionally-supportive responses in the products of the research is a key requirement. Indeed, where possible, a *bricolage* of opportunities should be observed, analysed and evaluated. A *bricolage* can be defined as a utilitarian approach, using what is available (Baker & Nelson 2005) and it is echoed in typical engineering postgraduate student approaches to language editing which typically involve multiple iterations, based on whatever resources are available. Clearly, new systems need to be engineered to layer science over myth (Lévi-Strauss 1966), so that the work is firmly rooted in what is identified by the students and supervisors themselves as being necessary to accelerate language learning within the discipline context and to support the students emotionally through the learning journey. If the language and discipline learning are aligned, then the learning becomes not only more necessary but also more relevant and hence appealing, heightening engagement.

This process is also relevant to L1 speakers of English as they move from undergraduate to postgraduate forms of writing, reading and communication. The differences between L1 and bEAL/D learners lie partly in some of the details of knowledge needed, but primarily in the speed at which the L1 speakers can accommodate and assimilate new learning. After all, L1 EHDRS tend to have lower levels of unconscious resistance and conscious time challenges of such learning, as they are already contained within the dominant discourse and culture (Timor 2018).

As such, the length, speed and delivery of the language courses, such as those delivered through CaRST (Adelaide Graduate Centre 2017a) may need adapting for the different learners, but the primary drive remains constant. This supports the idea that on-going training throughout postgraduate study is not only valid but highly desirable, as the teaching should be delivered at the point of need in order to be assimilated effectively, as well as in an appropriately engineering-style of delivery. In this way, language learning becomes a natural, fully integrated, concordant element of transitioning from undergraduate to postgraduate and then postgraduate to early career researcher.

The target end-users of the outcome(s) of this research are postgraduate students in Engineering, notably those studying for a Masters or PhD by research. Many of these students are EAL/D or bEAL/D and for many no dialect or tradition of English is their first language.

Even where a form of English is their nominal L1, there is still a significant transition to be made to achieve fully nuanced academic English within the genres of thesis and journal articles, with the hurdle of publication rejection being significantly higher and more alien for those who fall into the EAL/D grouping. This is a new challenge deriving from educational economics and the globalisation of academic learning. It is also a form of neo-colonialism, and as such can trigger resentment in the EAL/D, as well as the L1 postgraduate students.

Failing to extend English language teaching that is of an appropriate form of learning and teaching praxis can be seen as more than disempowering: it is exclusionary.

Although the assumption that academic English is a primary mode of transmission of information can be seen as hegemonic, the lived experience of students paying to study in English-speaking countries is that mastery of English is a form of currency in and of itself and, as such, should be taught appropriately, without condemnation of or from other forms of discourse.

The current research has its own particular context and its correlational outcome (Salkind 2012), as preliminary research, depends on the clarity of description of this context.

1.4.11 The specific context of the research

This early research study is located in metropolitan Adelaide, Australia, in the School of Mechanical Engineering (SME) and Faculty of Engineering, Computing and Mathematical Sciences (ECMS). The School is highly successful when measured against commonly recognised metrics such as Excellence Research Australia (ERA) rankings which measure the quality of the research outcome within a discipline as compared to the world standard. Due to Federal Government funding regulations, the SME, like many disciplines, is continuing to build on its current success by ensuring that the ever-increasing number of international EHDRS is fully supported in terms of language learning in order to increase timely completion rates, journal publications and effective communication skills of its graduates.

Whilst there is an established program of support for international students at university level, delivered through the overarching auspices of the Graduate Centre, the IBP-R (Adelaide Graduate Centre 2017c) is itself undergoing a process of transformation through the university-wide move towards School/Faculty provision of support for the new dynamic of the CaRST (Adelaide Graduate Centre 2017a) framework and is therefore separated from whole university provision of training. Thus, this review of learning and teaching in terms of English language development for engineering postgraduates is not simply focused on language learning in general but specifically on accuracy for academic language learning for engineers, notably in writing skills. This is to ensure that an evidence-based, tailored program can be created and integrated into the postgraduate engineering curriculum. The aim is to help drive up outcomes and efficient completions for the postgraduate students and the School.

The four common approaches to setting up language teaching are a hierarchy of strategies, from adjunct to embedded, as can be seen in Figure 1.12.

Figure 1.12: Continuum of support mechanisms (AGC 2017c)

Figure 1.12 shows the commonly accepted continuum for language teaching models in institutes of higher education across the globe, running from external to discipline course (adjunct, weak) such as the current model of the Adelaide Graduate Centre IBP-R (Adelaide Graduate Centre 2017c), through to a fully embedded course (embedded, strong), taught by the supervisors and supported by the language teachers.

In the School of Mechanical Engineering, the aim is to introduce an integrated, evidence-based, student needs-driven model so that the supervisors can retain their clearly defined role as discipline specialists who support research. In addition, the school offers an integrated language support on an ongoing basis, from language specialists, using pedagogy developed to accelerate writing skills and language development for all EHDRS, notably EAL/D students. Currently the model is adjunct to the central research program (and therefore early on the continuum above) and the aim is to bring it more strongly into the core requirements of the School.

The system of language learning must not encourage the desire for quick fixes and avoidance of detailed learning that stems from time constraints. Doing so would betray both the embedded humanistic values of the tri-partite solution and deny the centrality of language as means of academic communication, ultimately excluding the very students who are the focus of this study. This would betray the EHDRS' desire to be included in the English-speaking community. Therefore, acceptance of the time involved in language learning must be recognised and valued by both the EHDRS and their supervisory teams.

Analogy is frequently used to distinguish an engineer from other learners. This distinction will be shown to be an accepted paradigm in Engineering. Therefore, the new program of language study was designed to be integrated rather than adjunct, because it is focused on how engineers learn, what engineers need to learn and when engineers need to learn the disparate elements of language and writing for their program as defined by the students themselves. These were identified through the agency of the needs analysis (Table 3.2, Appendix 4) and semi-structured interviews, which accompanied this instrument. In this way, it taps into the key notions of learning readiness: a fundamental cornerstone of the growth mindset approach (Dweck 2015; O'Neil et al 2014). This is defined as the nexus of a student seeking knowledge and being willing to change their learning behaviour, going beyond the confines of English for academic purposes (Bruce 2008; Fenton-Smith & Humphreys 2015), systemic functional linguistics (Fries & Gregory 1995) and so forth, into a multi-faceted, humanistic approach or *bricolage* (Lévi-Strauss 1966).

This mode of learning can then be engineered to operate as a bank of carefully designed, focused learning possibilities to support language learning at an individual level for engineers, acknowledging the cultural, hierarchical and pedagogical impediments to learning, working around them to produce humanistic resolutions (Lucas, Hanson & Claxton 2014): in this case the tri-partite MOGTREE Solution. To paraphrase Mambrol (2016), the linguist becomes an engineer of signs: a craftsman or *bricoleur*, who deals with projects in their entirety, taking into account the availability of materials, and creating new tools in conjunction with the EHDRS; offering them a new, more appropriate *bricolage* from which to engineer their language skills positively and with confidence.

The first way of approaching the needs of these students was to decide how to group them in order to target and match their particular language needs. As a result of this, my first move was to seek to split up the L1 English speakers, EAL/D and bEAL/D students into three separate focus groups. Given the socio-cultural background of students, it was clear that their needs varied with their linguistic and cultural identification and experience of/immersion in academic English (Lupyan 2010). Bassnett (2002) defines this process of "translation" as being "an act both of inter-cultural and inter-temporal communication" (2002, page 10). Indeed, Shah and Missingham (2018) argue that what is required is for the students to be made aware of the explicit code-shifting involved in this process: that access to nuanced language is indeed beyond formal word-for-word translation and into the realm of semiotic rendering.

Thus, initially, I sought to differentiate Language 1 speakers of English who tend to work more quickly and with fewer tense and article errors, for example, from the bEAL/D students who are slightly less quick and may retain article, tense and vocabulary issues. The target 1/language 2 speakers tend to work more slowly and carry a wider range of grammatical errors that are not so evident for Language 1 speakers of English. However, the students expressed a clear wish not to be broken into groups or distinguished by language background, even though they understood that this would enable more targeted teaching, so this plan was abandoned at the first meeting.

The participants were happy with the idea of attending workshops, were delighted that their views were not only sought and valued but a key focus and understood clearly that the purpose of the exercise was to devise a system of language learning that was designed specifically for HDR engineers.

The participants and the researcher discussed how engineers learn and there was full agreement that the predominant learning modes are physical/tactile and visual/spatial. The solutions, therefore, must enable this kind of learning if they are to be successful. We also agreed that engineers are very used to using computers and like clear, supported answers: this is a fundamental issue that the students have with language learning; that it is not founded on clear rules at all times.

The students were also very interested in and passionate about the cultural aspects of language learning and that their own culture, as well as the target culture, must be respected throughout the teaching process. This is a very important element of the learning and teaching throughout the thesis, as cultural fit was not only raised during the needs analysis (Table 3.2, Appendix 4) as a crucial issue for EHDRS, but it is a recurring theme throughout the field notes.

The students were anxious that their privacy would be retained, so the systems of coding and de-identification were explained clearly.

We agreed to meet every four to six weeks with five key meetings to consider, discuss and ameliorate the following elements: 1) the initial meeting, discussion of the framework of the subsequent meetings; 2) ways of gathering the writing samples; 3) consideration of the design of a physical-tactile, visual-spatial language learning system; 4) consideration of the design of a form of collocation tool and 5) consideration of the design of a synergetic systems engineering approach to grammar.

It was also explained how the spirals work as part of a participatory action research approach. Spiral 2 consists of the three prototype solutions (the physical-tactile, visual-spatial language learning system), the concordancing tool and the synergetic systems engineering solution) that stem from the needs analysis (Table 3.2, Appendix 4) and writing samples (Tables 2.2, 3.3, 3.4, Appendix 5), which are the evidence base on which need is defined. Once each element of the solution has been tested once in prototype form (the language trees were tested in draft design form, the concordancing tool was tested in theory and the synergetic systems engineering tool was tested on paper only in the Prototype Workshops), the tri-partite solution was fully revised in the light of the Spiral 1 and 2 data. The final testing of the developed products individually and as an holistic approach, forms Spiral 3 and is critically important as it sets the success criteria for the system as a whole.

1.5 Aims

Any solution to the language needs of EHDRS ought to be culturally sensitive as well as linguistically accessible. It must counteract the current deficit model(s) and work to teach self-empowerment through support skills, rather than itself take a deficit model of learning. The cultural aspects of learning and teaching are essential, as language does not operate in a vacuum, devoid of social meaning. The individual lexical items of language systems (signifiers), represent socially-recognised concepts (the signified), rather than having any concrete or absolute connection with those concepts (Halliday 2012). Thus, this thesis aims to address this via a socio-cultural, humanistic approach.

English as a language is particularly difficult to master, as it is itself a polyglot, analogous language, given the British Isles' own turbulent history and our penchant for narrative through oral history (Crystal 2007; Deutscher 2011). This is reinforced in Australia by its own particular colonial history. The division between larrikin, colloquial Australian and formal, academic Australian English is significant. For a list of languages that are challenging to learn for English speakers (thereby acknowledging divergence), see Appendix 2 (Foreign Service Institute 2018). This thesis aims to address this by teaching register and working at field, tone and tenor levels, revealing the continuum of language explicitly.

The English language is layered into formal and informal lexical items and phrases (primarily Latinate in the former case and Germanic in the latter), which is confusing enough, particularly for those of a non-European background. The difference between very spoken and very written language is often the difference between the tested communicative competence and the university-required nuanced academic English

(Fries & Gregory 1995; Lakoff & Johnson 1980): for EHDRS to navigate this successfully requires nuanced, supportive, theory-driven support, which this thesis aims to address explicitly.

1.6 Summary

The achievement of an embedded, detailed course, tailored to its users' needs by design from practice architecture to delivery, will break new ground in terms of Engineering Education, itself an emergent discipline. The approach taken foregrounds the EHDRS at the heart of the research, emphasising the need for relevancy, appropriacy and respect for all stakeholders.

The research is grounded in Education and Linguistic theory, and tested through a series of participative action research spirals (see the Discovery, Prototype and Product Spirals). It is predicated on a needs analysis (Table 3.2, Appendix 4), analysis of samples of student work and built-in partnerships with the students. These all affirm that the solution must not only include self-editing and intrinsic motivation and reward, but also generate its own self-reflection as each cohort moves through candidature, supporting language-learning in both socio-affective and academic frameworks, in order to support the emotional and cultural needs of the language-learners.

Chapter 2.
Research framework and methodology

2.1 Introduction

This chapter focuses on the minutiae of creating the research thesis, from the paperwork to the details and thinking processes behind each element. It includes the process of gaining ethics clearance to work with the EHDRS, the process of setting up the workshops and building the underlying teaching pedagogies that will frame delivery of the workshops.

2.2 Scope

2.2.1 Ethics Clearance

Low level human ethics clearance was sought in order to run the testing cycle with participants drawn from the School of Mechanical Engineering at the University of Adelaide. Ethics clearance (H-2015-200) has been maintained throughout the research (see Appendix 3: HREC paperwork).

Part of the early discussion was to involve the EHDRS, a group of supervisors and a group of linguists to assess the needs analysis (Table 3.2, Appendix 4) and the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5). In reality, all the academics were time-poor and lacked availability and at least one key academic changed jobs (to take a promotion interstate), so it was both more expedient and more effective to work with the students alone. The EHDRS were, and remain, sufficiently articulate to identify their needs.

Participative action research spirals were used throughout the testing process (Figure 2.1) as the feedback loops ensure that the EHDRS' voices are heard, valued and incorporated actively into the research at each stage.

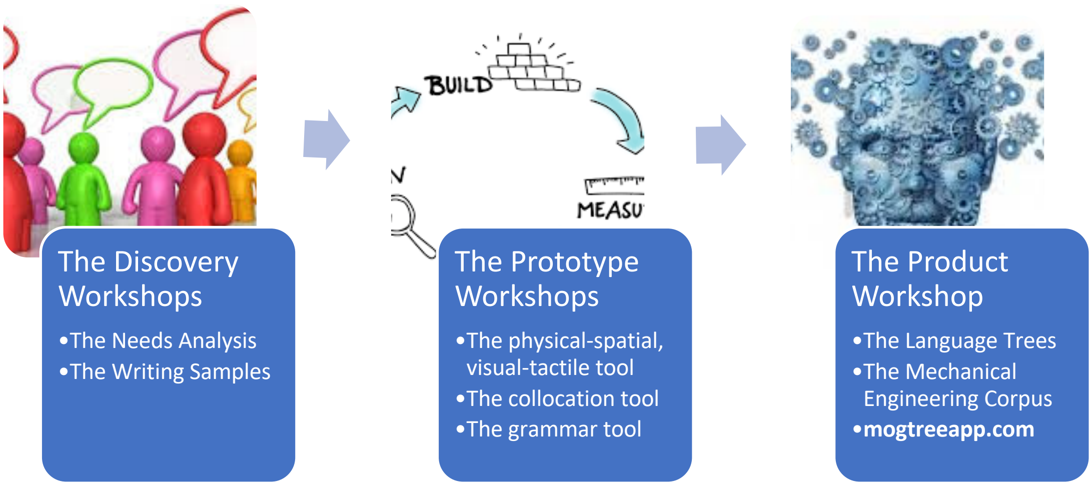


Figure 2.1: An outline of the participative action research spirals. The Discovery, Prototype and Product Workshops.

The ethics clearance specifies that the EHDRS' contribution is to be de-identified. In Spiral 1, the only issue with the numbered writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) is that the topic could lead to identification by a supervisor, but the students were not required to write on their thesis topic, just engineering. This was made clear to all the participants. The samples were numbered in the order in which they were handed up and the names removed from all documents, using only the allocated numbers as soon as the writing samples were corrected and returned individually, by email. No student withdrew from any of the testing. One left the university and others were unable to attend all the workshops on a regular basis, but none withdrew consent. The right and ability to withdraw participation at any point was made clear in the invitations and at the start of each workshop.

In Spirals 2 and 3 the responses were renumbered as, although some of the participants remained from Spiral 1, there was no way to identify individual workbook responses, even though there were records of who was in the room for any given workshop. Given that the materials under review were very different, treating the Spiral 2 and Spiral 3 groups as wholly new is logical.

It will be observed that in Spiral 3, the graphs show a small, growing number of zero responses. This reflects the fact that a small group of the students let me know in advance that they needed to leave early as they had supervisions or job interviews. It was agreed that if they would come for any of the workshop, their responses would be recorded and fed into the outcome, so their voices would be heard, but of course they must attend supervisions or job interviews, so they should leave early where needed. Thus, the zeros for the Spiral 3 workshop are not negative comments but rather positive affirmation that the responses were indeed voluntarily shared, and no one was pressured either to come or stay beyond what was easy for them. Under the circumstances, the zeros are very positive affirmation that the ethics rules were applied with integrity.

All paperwork associated with the research has been kept safely, in accordance with the ethics paperwork. Files will be stored securely in the School of Education for seven years and then destroyed. All working files are kept in a locked cabinet, in a locked office until needed. Electronic files are password protected and kept on the University web-based system, as per the HREC guidelines.

2.2.2 The participants

The participants were originally sought only from the School of Mechanical Engineering. The invitations were issued as per the requirements of the ethics committee. No incentives were offered: this project relies on the engineers being willing to engage with tough questions about language and learning on an altruistic basis. The potential benefit to the students themselves was that they would be able to shape language teaching in the School of Mechanical Engineering. This ethical basis gives the research great integrity.

The invitations were sent to all first to third year PhD candidates via the School's group email system (that is, to all postgraduate students in the School of Mechanical Engineering) in the first instance. The reason those beyond third year were not included was that they would be likely to leave before the end of the testing process and this could create inconsistency. No responses were received, so the plan was revised to make the testing sequence more welcoming to potential participants, without applying any pressure on any individual.

Individualised email invitations were then sent out with a brief summary in the body of the email and the detail as attachments. It was felt that this would be more likely to be read by busy engineering students who receive a high volume of emails, many of which are irrelevant. The net was also widened throughout the Faculty of ECMS, for those who had already attended language courses in the School of Mechanical Engineering and therefore had shown an interest in language learning. They also received personalised invitations, with assurances that there was no pressure to participate.

Finally, flyers were distributed by hand to each HDR student office, inviting the students to come along face to face, with any positive replies to come by email, as per the flyer. All questions about the process, privacy and nature of the research were answered as they arose in each office. Sixteen responses were received. No more than five ever attended any of the workshops at any one time, so the workshops were repeated multiple times to try and obtain as many responses as possible across the testing period.

In order to be able to quote the participants, whilst still protecting their identity, they were allocated numbers from 001 to 016. The order simply derives from the order in which the Writing Samples (Tables 2.2, 3.3, 3.4, Appendix 5) were collected and hence coded and has no other connotation. The original writing samples have the names on each response, which enabled the coding. Once the coding was in place, the original names were removed to protect the participants' identities. These codes are used throughout the thesis. For full details, see Appendix 5, the writing samples, with this 001-016 coding applied, and the full collection of annotated samples.

Next, a broad outline of the background of the cohort of participants in Spirals 1 and 2 was collected (Table 2.1). The data shows the School attended within ECMS, gender, age group and language background of the participants, enabling comparison with the Spiral 3 cohort and the EHDRS at the University of Adelaide. From Table 2.1, it is clear that there are a range of engineering backgrounds within the group, with a predominance of Mechanical Engineering students. The group is overwhelmingly male (which reflects the cohort). The students have often worked in industry between their first and potentially second degrees before returning to complete a PhD and have a wide variety of language backgrounds.

Table 2.1: Cohort completing the Discovery and Prototype Workshops (ECMS schools, gender, age and language backgrounds of the 16 participants in spirals 1 and 2.)

N=16								
University of Adelaide:	16	PhD:	16					
ECMS Schools:	Mechanical Engineering	13	Electrical Engineering	1	Petroleum	1	Computer Science/ Mechanical Engineering	1
Gender:	Male	15	Female	1				
Age:	18-25	4	25-50	12	50+	0		
Language:	L1 speakers of English	2	English as an Additional Language or Dialect (EAL/D speakers)	10	Background EAL/D	4		
Other language(s) spoken:	Greek (1)	Italian (3)	Persian (2)	Khmer (2)	Mandarin (5)	German (1)		

Six languages other than English are spoken as L1 within the group and four participants have another language in the background (that is, spoken as a first language by either their parent(s) or significant carers, such as grandparent(s)). Of these, three have background Italian and one has background Khmer. Two of the participants are L1 English speakers.

2.2.3 Formulating the Workshops

Socratic questioning, as per the Harkness method, is also familiar as a research structure for Mechanical Engineering postgraduates, particularly those who completed their undergraduate studies at the University of Adelaide. It articulates strongly with the Optimising Problem Solving (OPS), Research Skills Development (RSD) Pentagon developed within the School of Mechanical Engineering. In the OPS pentagon (Figure 2.2), “Communicate and Apply”, “Find and Generate”, “Evaluate and Reflect”, “Organise and Manage”, “Analyse and Synthesise” surround the central research/learning goal of “Embark and Clarify”. Socratic questioning, which encourages students to research answers for themselves rather than expect to be given answers by a teacher, is also used in all Communications courses marking at Levels 1 and 3 (Hunter et al. 2017). The OPS Pentagon (Adelaide University 2018) was devised by a group of Tutors in the Professional Practice course (Mechanical Engineering Course 1006) at the University of Adelaide. It is designed to train engineers to break down problem solving into its constituent parts. It is fully aligned with the engineering method, and so uses the familiar (the known) to generate solutions to the unfamiliar (Cope & Kalantsis 2008).

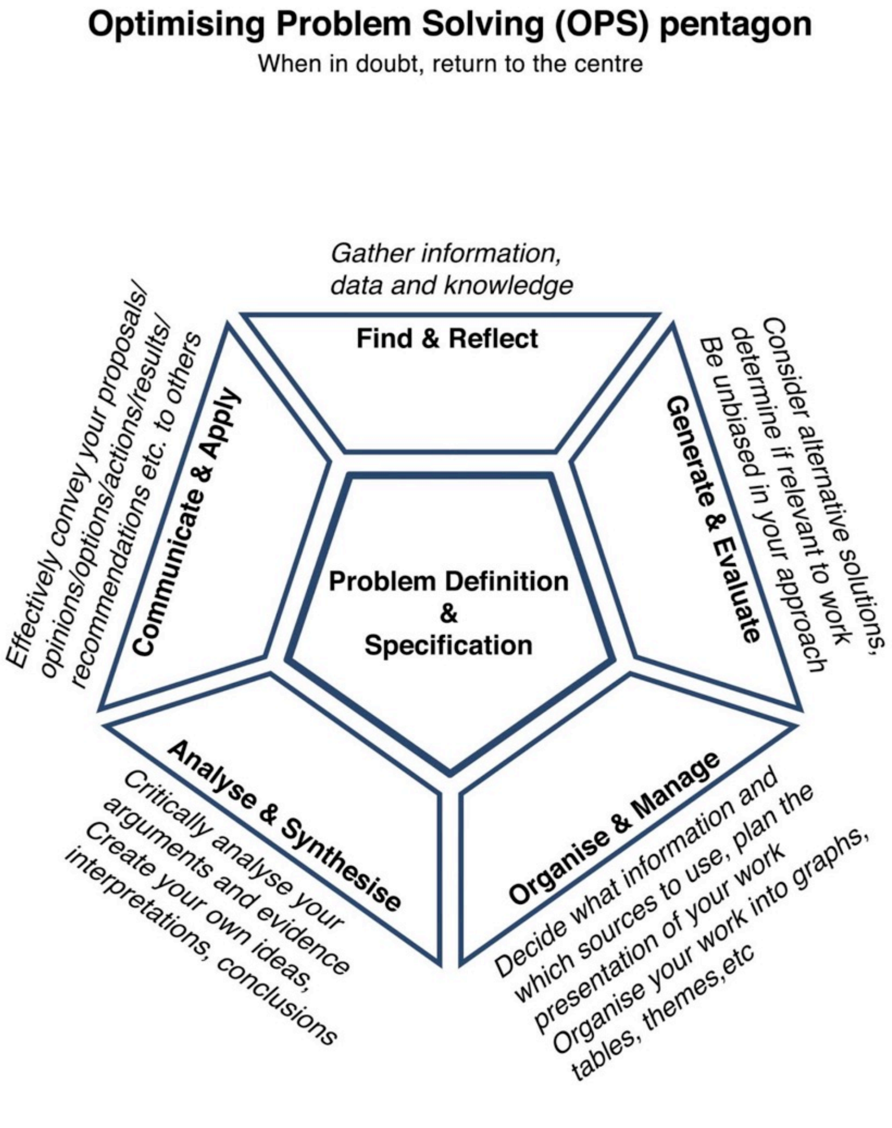


Figure 2.2: The OPS Pentagon (Adelaide University Engineering Tutors 2018)

Having established the research group by gathering participants, dates were set for our meetings. Each workshop was designed to invite comment, discussion and suggestions for improvement in a friendly, open forum. Notes were taken throughout. The students were invited to write down their thoughts, but mostly preferred to think aloud, delivering their opinions orally. Where the EHDRS' comments are quoted, the participant number is given. Some students did not feel confident to speak in the group, and so met with the researcher separately. Where this happened, the focus was on their cultural needs and wish to be taken seriously as a researcher in a Language 1, English-speaking environment. Participant 012, for example, put this particularly eloquently: "*Whatever you do, please ensure that you stress the need for cross cultural understanding. We already have knowledge. We are not empty vessels. We deserve respect. You must help make sure the help offered is consistent across the School*". Thus, the focus on cultural understanding, norms and the drive to align new knowledges with prior learning is central to this thesis.

The workshop consisted of four elements.

1. A presentation of the outline of the research and clarification of the protocols, especially that the EHDRS can leave at any point with no comeback whatsoever. The outcome of the work required more altruism than self-interest: to prepare and shape an evidence-based solution to the EHDR issues that pertain to language and writing.

2. Issuing of the first questionnaire: the needs analysis (Table 3.2, Appendix 4). This was designed as an open question to gather data and reassure the EHDRS that they were an active part of this research and have significant input into its

design and outcome. This discussion generated data from which to build and measure the efficacy of the responses to the needs analysis.

3. Opening up the discussion after the needs analysis was completed to check for common threads. The data included the emotional responses of the students and therefore contains qualitative data on which to build.

4. Collection of the writing samples. Again, the data included material from which to measure change.

The question that is the focus for the needs analysis (Table 3.2, Appendix 4) was discussed with the group. The version used asked: "*What support do you need with developing your language skills?*". The reason for such an open question was that it would not craft or foreshadow answers: it was important that the EHDRS were able to take an active role from the outset in this research. This openness built information, trust and integrity into the work. Thus, as part of the initial discussions about student needs, the participants were asked what they wanted to achieve through the research. It is noticeable that the requests go well beyond the aims and objectives of the IBP-R.

The learning and teaching approach that would best fit these learning needs was identified, along with consideration about their delivery. Short, medium and longer-term course formats are all available, via CaRST (Figure 2.3) so it was important to focus on how to strategise the learning and teaching process that would stem from the core research. There were three broad areas of improvement the students identified and wanted addressed: those concerning English for academic purposes and grammar; those which broadly fell only at the level of grammar (a very broad, non-technical definition, as above); and those which are whole School issues.

At university level, language teaching for postgraduate students comes under a new system called CaRST (University of Adelaide 2017a). This is a new, formalised program of training, covering a broad spectrum of skills.

There are four domains in the CaRST program (University of Adelaide 2017a). Domain A: Knowledge and intellectual abilities; Domain B: Personal effectiveness; Domain C: Research governance and organisation and Domain D: Engagement, influence, and impact. Each is then broken into subsections in order to cover the skills needed to create and disseminate research with integrity (Figure 2.3). The building stones of CaRST are the Vitae framework for research skills (Adelaide Graduate Centre 2017a).

The CaRST program is not designed to differentiate those with EAL/D backgrounds or those with international backgrounds in big picture, although there is a stream within CaRST to cover training for international students called the IBP-R (University of Adelaide 2017c). There is a further issue, obviously, that not all international students speak English as L2 (or more) and not all domestic students are L1 English speakers, so issues remain. This is a new system from 2017, so it is under intensive review and refinement.

The writing support classes within the School of Mechanical Engineering nestle within this program, as well as without. CaRST hours were available for attendance at the workshops but they were neither advertised nor administered by the Adelaide Graduate Centre. The positive effect of this is that the School of Mechanical Engineering is able to run the support classes that it needs for its own students, on its own timetable and with staff of its choice who are trained to the particular writing needs of EHDRS. However, these classes are additional to the IBP-R, which is able to exert additional pressure on students to attend. This can be a powerful disincentive for time-poor EHDRS.

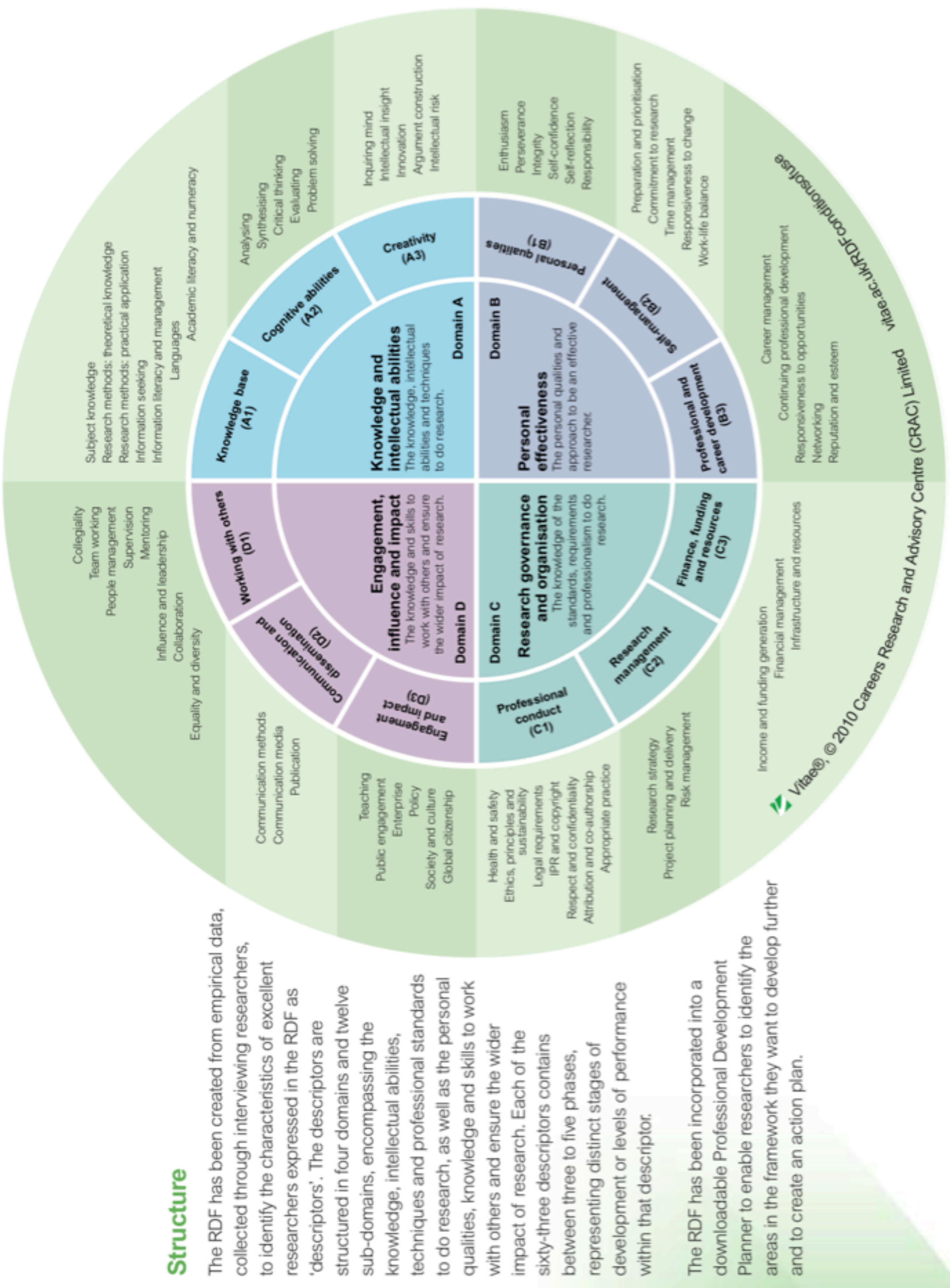


Figure 2.3: The building stones of CaRST (AGC 2017c; vitae 2017)

PhD candidates must complete 120 hours of courses to acquire the additional CaRST qualification, alongside their doctorate, with a minimum of 10 and a maximum of 60 hours in each domain.

Completing the IBP-R involves undertaking three components: 12 discipline-specific seminars, 12 lectures, and consultations (by appointment) (University of Adelaide 2017c). The program aims to develop independent research skills, research communication skills, critical thinking and problem-solving skills, teamwork, intercultural and ethical competency, along with self-awareness and emotional intelligence training. There is some disquiet in the student body about the course and it is still under review. It carries CaRST hours but does not replace other, perhaps more detailed and subject specific, training.

The Product Workshops in this research were accredited through CaRST. This was seen by the researcher as a pragmatic way to reward attendance and was popular with the EHDRS.

2.3 The Participants' Language Competency Background

2.3.1 Introduction

The first part of this chapter sets the scene for the theory underpinning the workshops. Participative action research spirals were introduced as an experimental framework, taking a synergetic systems engineering approach. It was important to gain acceptance of these qualitative approaches, so that the EHDRS themselves saw the research process as valid, even though it is not a typical (predominantly quantitative) engineering approach. By meshing the language of the two approaches together (qualitative and quantitative), the students are able to translate the research processes into language and ideas that make sense to engineers.

Background, contextual information about the participants was gathered in terms of their linguistic and cultural histories, abilities and skills. For this sample N=16. The cohort is broken into three parts: bEAL/D; EAL/D and Language 1 (L1, who can also be described as "mother-tongue" or "native") speakers of English, Table 2.2. L1 is the term used in this thesis as it avoids patronising and/or colonial implications. The responses of the students will be considered in the light of their language context, social and academic needs, as per their request.

Table 2.2: Numerical Analysis of the English language status of the cohort completing the Spiral 1 writing samples workshop. N=16.

Language	**Numbers of students**
Primary Language (L1) English	2
EAL/D	9
bEAL/D	5

It is important to note that although seven participants consider themselves as L1 English speakers, of that number, five have background EAL/D language complexities, which are revealed in both Writing and Reading and not in either Speaking or Listening.

The following part of this chapter is focused on the learning architecture of the workshops and the establishment of the needs analysis (Table 3.2, Appendix 4): the students' own identification of the types of help they felt they needed with language development. These ideas were analysed and condensed to start building a range of responses, both in terms of new solutions and in terms of the pedagogies that will underpin and humanise the solutions.

Next, a set of writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) was collected, and evaluation was made of the typical writing errors within the testing group. This data was cross-matched with the needs analysis (Table 3.2, Appendix 4) responses.

Finally, the data are drawn together to move towards creating solutions to the issue of EHDRS' language learning and interim conclusions were drawn.

2.3.2 Creating positive learning spaces

Having established the strong need for the students to be part of shaping both the solution and its delivery through the initial consultations with students and research about engagement, it became critical to consider the mode of delivery of the questions and testing. A format was required that is egalitarian in nature, non-imposing and positive, encouraging critical thinking on their part as well as that of the researcher, and which avoided a negative or authoritarian approach. Various issues were considered, one of which being the mode of delivery.

The mode of delivery of the workshops was also vitally important for their success, given the emotional reaction to the grouping proposal above. Without an engaging, engineering-orientated protocol, which is both familiar and iterative, thereby linking with the engineering method (Lasser 2013), there was a risk the EHDRS would reject the research process as it will be deemed remote and irrelevant. The engineering method has six steps: 1) idea generation, 2) concept generation, 3) planning, 4) design generation, and 5) development, including 6) the iterative cycle of build, test, debug, and redesign. This iterative, engineering-friendly approach to language learning needed to be both embedded in the praxis and repeatable if it is to become embedded in learning, rather than lasting only for the duration of the doctoral (PhD) research.

This research has an authentic purpose: to ameliorate the traumatic academic writing problems for the University of Adelaide Mechanical Engineering postgraduate students and become the research-based foundation of a new generation of language courses offered to this special population, lowering the attrition rate and increasing completion and publication rates.

As such, all elements needed to be considered from timing of classes, to the culture within the classes, to the practicalities of reproduction of the learning process. This is particularly important given that the EAL/D international students in particular are entering a hybrid space; that is, one that is culturally, socially and linguistically alien, which can be a cause of deep isolation, attacking well-being alongside learning opportunities (del Carmen Salazar 2013). Participant 011 summarised this during a Discovery workshop in the plea*: "Please take into account that we are not stupid in our own languages and countries. We are here because we are good at Engineering"*.

In order to generate a positive learning space, it was vital to remove all aspects of discrimination and alienation, and move into a positive, shared learning environment for creative meaning-making.

The purpose of the workshops was to explore the language learning needs, skills and processes for EHDRS, following the participative action research methodology. Throughout, there was an active and open focus on the students' own perceptions of their issues with language and writing, specifically as engineers working in the academic field. The workshops, therefore, invited active participation in an open field, rather than operating as content-driven, pre-determined teaching sessions. The researcher aimed to be linguistically and emotionally silent beyond suggesting questions or inviting further comment, so that the student voices could be heard clearly.

All the workshops in Spirals 1 and 2 took place in the Davis Room, in the School of Mechanical Engineering, at the University of Adelaide. This is a conference and meeting room with which the students are familiar. It is safe, open and comfortable as a place in which to work. The room had the potential for a central focus on a whiteboard, although the desks were arranged in a circle, along the lines of Harkness learning (Williams 2014).

For each workshop, the pedagogy was based about a particular form of discussion-based learning, known as Harkness learning. This pedagogy is based on equality of learning within a group. Thus, the circle is important as it removes hierarchy from the learning and teaching situation. This is fully in keeping with participative action research methodology that underpins this research focusing on complementary and collaborative exploration of ideas. Furthermore, this pedagogic strategy avoids taking a deficit model to the teaching: a point which is clarified for the students in the introductory meeting. At no point was there a discussion of student failings: the purpose of this research is to move learning forward effectively, not to criticise the students or make them feel their current learning is unacceptable. This is crucial as a deficit model inculcates a culture of blame and lack of trust, neither of which produce positive solutions and participant buy-in to the vision under development.

The learning and teaching cycle across all the workshops is as follows (Figure 2.4). Note that the workshops start with an evaluation of need (the needs analysis), then the cycle is used for each section of development.

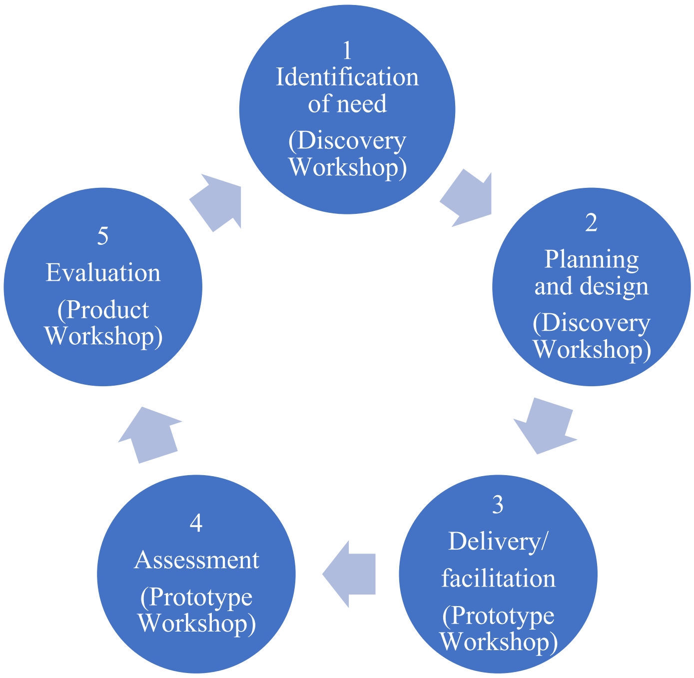


Figure 2.4: The workshop training cycle echoing the Discovery, Prototype, Product pattern of the Workshops (Payne 2014)

It should be noted that this training cycle also matches the engineering design model (as indicated in Figure 2.4), and so is familiar to the EHDRS as a mechanism for research.

2.3.3 The Harkness method

In terms of the learning and teaching architecture, a method was sought that aligned with the iterative, student-driven nature of the research itself, so that the the learning environment would match the method of research and create a supportive, rather than a deficit, learning and teaching space. This extended beyond the theoretical to the physical learning and teaching design.

A very accessible, university-style approach to knowledge discovery is the Harkness method. This method was created in the 1930s in the United States in order to stimulate student-centred, critical thinking. It literally centres around the arrangement of the learning space (the learning architecture, both physical and conceptual), which is a round or oval table where all members of the class are invited equally to engage in a community of learning practice or social learning experience. It involves questioning, contributing and contemplating ideas alongside each other, with the teacher as the facilitator, rather than keeper of all knowledge, sitting alongside the learners. This process generates a situation where the students learn how to learn, rather than engage in rote learning, and so it is particularly positive in terms of engagement, equality and visible/audible learning, that is, the metalanguage of learning (Cadwell, 2017). It is by definition both social in nature and inherently positive, thereby engaging with the social nature of language and supporting well-being by sharing control across the learning community.

Alongside this, the Harkness approach (Figure 2.5) offers a Socratic, questioning feel, in that it relies on questions to generate complexity, but by engaging in peer learning and review, it avoids the negativity of more mainstream approaches to Socratic questioning, which assume that there is a truth to be discovered and a teacher who is the holder of that truth (Harrison et al 2018). As such it is iterative (and therefore familiar as a mode of cognition for engineers, as per the engineering method, egalitarian and articulates effectively with the iterative nature of participative action research spirals within the learning space (as identified and supported as a key need in the needs analysis).

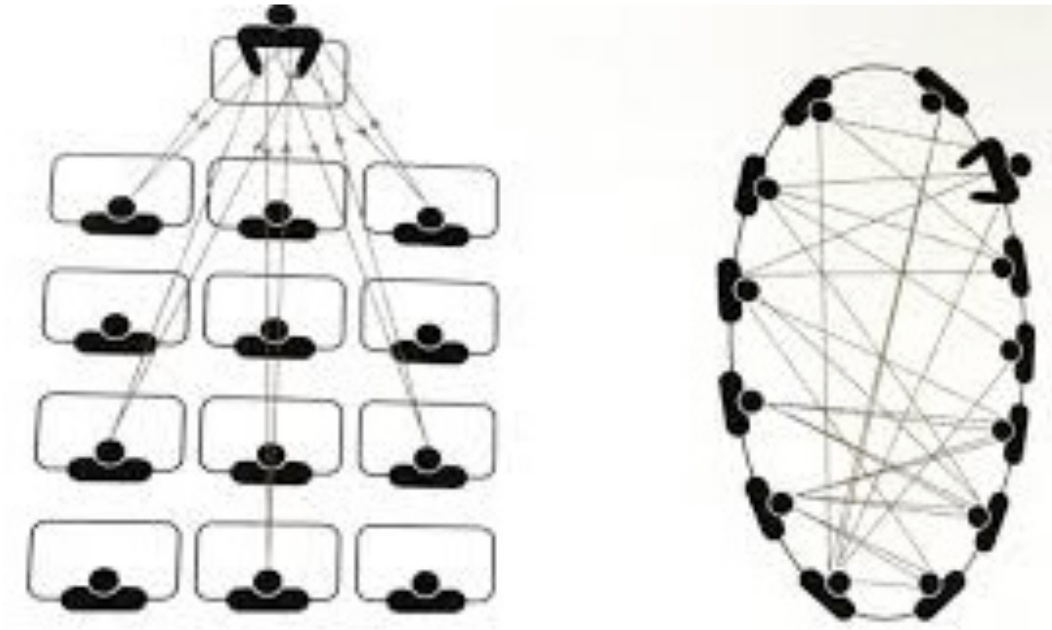


Figure 2.5: Traditional teaching architecture (left) versus the Harkness teaching architecture (right) (Abbott-Jones & Spencer n.d.)

2.3.4 Evaluating options

The first way of approaching the needs of these students was to decide how to group them in order to target and match their particular language needs. As a result of this, my first move was to seek to split up the L1 English speakers, EAL/D and bEAL/D students into three separate focus groups. Given the socio-cultural background of students, it was clear that their needs varied with their linguistic and cultural identification and experience of/immersion in academic English (Lupyan 2010). Bassnett (2002) defines this process of "translation" as being "an act both of inter-cultural and inter-temporal communication" (2002, page 10). Indeed, Shah and Missingham (2018) argue that what is required is for the students to be made aware of the explicit code-shifting involved in this process: that access to nuanced language is indeed beyond formal word-for-word translation and into the realm of semiotic rendering. However, the EHDRS saw this as taking a deficit position, so this plan was abandoned on affective grounds at this point, though they later moved into these groups through the process of delivering the needs analysis, giving them control of their self-identification.

The participants were happy with the idea of attending workshops, were delighted that their views were not only sought and valued but a key focus, and understood clearly that the purpose of the exercise was to devise a system of language learning that was designed specifically for HDR engineers.

We discussed how engineers learn and there was full agreement that the predominant learning modes are physical/tactile and visual/spatial. The solutions, therefore, must enable this kind of learning if they are to be successful. We also agreed that engineers are very familiar with using computers and like clear, supported answers: this is a fundamental issue that the students have with language learning; that it is not founded on clear rules at all times.

The students were also very interested in and passionate about the cultural aspects of language learning and that their own culture, as well as the target culture, must be respected throughout the teaching process. This is a very important element of the learning and teaching throughout the thesis, as cultural fit was not only raised during the needs analysis as a crucial issue for EHDRS, but it is a recurring theme throughout the field notes.

The students were anxious that their privacy would be retained, and the systems of coding and de-identification were explained clearly.

We agreed to meet every four to six weeks with five key meetings to consider, discuss and ameliorate the following elements:

1. The initial meeting, discussion of the framework of the subsequent meetings;
2. Ways of gathering the writing samples;
3. Consideration of the design of a physical-tactile, visual-spatial language learning system;
4. Consideration of the design of a form of collocation tool and
5. Consideration of the design of a synergetic systems engineering approach to grammar.

An explanation was given as to how the spirals work as part of a participatory action research approach. Thus, Spiral 1 consists of the needs and writing samples. Spiral 2 consists of the three prototype solutions (the physical-tactile, visual-spatial language learning system, the concordancing tool and the synergetic systems engineering solution) that stem from the needs analysis and writing samples), which are the evidence base on which need is defined. Once each element of the solution has been tested once in prototype form (the language trees were tested in draft design form, the concordancing tool was tested in theory and the synergetic systems engineering tool was tested on paper only in the Prototype Workshops), the tri-partite solution was fully revised in the light of the Spiral 1 and 2 data. The final testing of the developed products individually and as an holistic approach, forms Spiral 3 and is critically important as it sets the success criteria for the system as a whole.

It was clear, through these early discussions, that the EHDRS wished to be seen primarily as engineering postgraduate students, rather than language learners. This is both a strength as it articulates with their core engineering business, and a weakness as it de-prioritises language learning. This de-prioritisation was a theme that ran throughout the research and underlay the issues with data collection throughout the research. Attendance at workshops was consistently irregular and often the workshops had to be run multiple times (sometimes at individual level) in order to ensure sufficient attendance. The correspondingly higher numbers attending the Spiral 3 Product Workshop (N=21) underlined this desire for language to be managed swiftly and outside regular doctoral student (PhD) hours.

The Prototype Workshop was also attached to CaRST hours (Adelaide Graduate Centre 2017a). Domain A hours (Knowledge and Intellectual Abilities: see Figure 2.2) are, nonetheless, particularly sought after, as few external providers engage with this domain. It was important to get the Writing Workshops classified in this Domain, which involved persuading the CaRST management that the language being taught was part of an academic language program, not a communications program. Appealing to the academic program rules as a source of rationale and authority is supported by research by Bednall (2018):

> *"Supervisors have an important role in providing a realistic preview of academic life. One useful exercise is to review an academic competency model, such as the* Vitae Researcher Development Framework *(on which the CaRST framework is based), to discuss which skills academics need. In addition to knowledge of their topic area and research methods, academics increasingly need to be good at managing complex projects, working in multidisciplinary teams, and engaging with industry and media. This discussion should enable supervisors and students to plan how students will develop their capabilities. Alternatively, it could prompt some students to opt out of a research degree if they think an academic role is not compatible with their goals."*

The EHDRS' reluctance to being put into what they were afraid were arbitrary or value-laden groups was my first lesson in working with this cohort. The EHDRS did not wish to be organised by an outsider; they wished to organise themselves, which boded well for independent thought and responses. The participative action research spirals (Cohen, Manion & Morrison 2013) lend themselves well to this kind of iterative approach, sharing power and enabling revision at every point of the research, as the research itself loops forwards and backwards, revising the questions as new, potential answers are located and considered.

It also became clear that my twin roles as both researcher and peer student, were importantly ambivalent and enabled the collection of more detailed, honest qualitative data, as the students came to identify with my position as a peer more readily, whilst accepting my knowledge base as a researcher.

Having introduced the project to the students and reassured them that their voice was central to everything, we agreed that a needs analysis (Huddlestone & Pike 2016) would be a suitable, engineering-style approach to working out what the problems are and what priority the students give to the problems they perceive, so that these can be built into the solution, giving the EHDRS ownership of each element of the work.

2.3.5 Introduction to the pedagogical frameworks of the workshops

A key feature of the learning and teaching context was the Harkness method (Shapiro 2001 in Cadwell 2001). This approach is respectful of all prior knowledge and builds on learning experiences, with equally valued contributions. However, the facilitator needs to be aware of the disparate nature of these experiences and how these experiences are etched into the learning modes of the students. It is not sufficient to announce that all learners are equal when that has not been the learners' experience, so the positive catalysts for learning must be explored, located and drawn on in order to embed, extend and facilitate learning.

The hegemonic nature of learning in a postgraduate situation, comprising goals, milestones and the pressures of time and finance, is coupled with the human trauma, joy and resilience required for success. Creating a safe, positive, social space for learning, where mistakes are learning markers and achievements are celebrated jointly is essential and must be built into the solution(s).

A second philosophical framework for the pedagogical approach to this new way of language learning, lies in the Lévi-Strauss (1966) conceptualisation of the engineer and the *bricoleur*. *Bricolage* can be defined as a utilitarian approach, using what was available (Baker and Nelson 2005) and it is echoed in typical engineering postgraduate student approaches to language editing which typically involve multiple iterations, based on whatever resources are available.

Thus, the *bricoleur* (the person undertaking *bricolage*) takes a radical approach to searching out knowledge which is both intrinsically entrepreneurial in nature: innovative, creative and ultimately unstable, and also highly pragmatic (Stinchfield, Nelson and Wood 2012). Similarly, EHDRS will typically (as they have done in some of the baseline data) rely for help on general language apps and concordances not designed for engineers let alone postgraduates, other international (often EAL/D) students and the internet, including Google Translate, rather than ask specialist language teachers, knowing that their work will ultimately be edited at the end by an editor who is an L1 speaker of English. The EHDRS perceive this as being quicker and less shameful than asking for lessons along the journey, when they are under time pressure from supervisors. As Mambrol (2016) argues, the students can be seen as operating as *bricoleurs*), scrabbling at extant signs without consideration of original purpose. The pedagogy must therefore acknowledge and work around this impulse to find the simplest way forward in an immediate situation in order to build long-term solutions to the issue of language control.

In this way, one of the key imperatives for developing and integrating language teaching into postgraduate learning practice is to ensure that the new, engineered form of *bricolage* on offer is actually designed for engineers: is appealing visually as well linguistically, highly accessible and self-enabling, so that it becomes the engineered first choice foundation of the EHDRS' work (Gilakjani 2012). Another key element is that the aspect of integration or embedding of this approach is critical, so that the supervisors support the linguists to support the students, ensuring that a positive sequence of learning and teaching occurs.

There is a range of core designs that are relevant to a conceptualisation of language learning that are relevant for this research. Interestingly, Janssen et al. (2016), who evaluate learning from an Industry 4.0 perspective, show that virtual learning can be the equivalent of traditional learning if it also provides a setting via a headset which gives a visual-spatial, kinaesthetic, immersive learning experience. Industry 4.0 has relevance here as it intersects with current education development thinking (Moore 2018):

> "Industry 4.0 is the label given to the gradual combination of traditional manufacturing and industrial practices with the increasingly technological world around us.
>
> This includes using large-scale [Machine to Machine] M2M and Internet of Things (IoT) deployments to help manufacturers and consumers alike provide increased automation, improved communication and monitoring, along with self-diagnosis and new levels of analysis to provide a truly productive future."

It would be possible and fascinating to take this research into the virtual world via further research at postdoctoral level, though it is beyond the scope of the current thesis.

In the next section, the core of the solution, the humancentric (cultural, academic and emotional) needs of the participants are explored.

2.3.6 Unpacking participant characteristics

Table 2.1 presents an outline of the cohort who took the Spiral 1 Workshop: whilst it already gives useful information, more can be inferred. There must be a number of international participants given the languages of origin shown here, who may or may not have experienced alienation within Australian cultural systems. A number of the EHDRS identified as EAL/D or bEAL/D and so may have experienced linguistic alienation. A number have non-Australian backgrounds and so may have felt excluded socially from a variety of interactions and learning processes.

Given the numbers of participants, a few, at least, of the EHDRS may have a diagnosed, or undiagnosed learning difficulty such as autistic spectrum disorder (imeche.org 2014) or dyslexia (Schneps 2014). These suggestions are supported as potential challenges (without claiming to offer a diagnosis) by some of the comments made on the process of learning (for example Participant 15 explained: "*I can see that this is a good, social way of learning. I do not do social*"). Whilst the university maintains lists of those students with divergent learning patterns/modes, those difficulties may not be reported or, indeed, formally recognised. In order to work around this, (a) complex, sensitive solution(s) must be developed, or the solution(s) will enhance rather than overcome powerful elements of cognitive dissonance for a number of the EHDRS.

The elements of age, gender and formal prior learning experiences also hint at approaches to learning that have critical contexts. Creating a praxis that promotes well-being is essential for a successful humanistic approach to learning. This is demonstrated by the schematic developed by Smith (1994) (Figure 2.6).

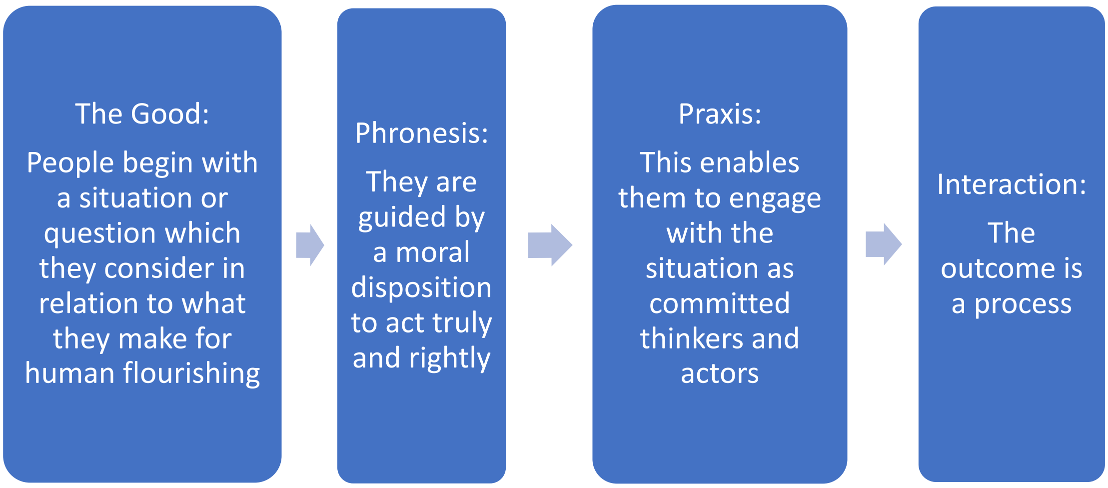


Figure 2.6: The degrees of theory underpinning humanistic pedagogy (Smith 1994)

The background and contextual data on the participants show that the individualities, complexities and nuanced experiences of the whole cohort are extremely diverse, powerful and this fact is reflected in terms of the effect of the workshop on the students. These elements, in turn, covertly and overtly, affect the findings in terms of the reviews, opinions and reflections shared. This makes the qualitative data situational, however it retains validity as it is authentic to the current situation of EHDRS in the School of Mechanical Engineering and the Faculty of ECMS in the University of Adelaide, in metropolitan South Australia.

2.4 Conclusion

In order to generate a creative, playful, aligned pedagogy and praxis for the learning of nuanced language, it is necessary to incorporate a wide range of elements into the learning approach. As has been argued, such an approach needs to show respect to the humans at the heart of the learning by taking a humanistic approach and teaching language learning explicitly through the use of the meta-language or grammar of language.

Such an approach to learning and teaching also needs to consider the physical space in which learning is to occur so that it is conducive to an egalitarian, social approach to learning and to language itself. The teaching needs to be multi-sensory, problem-solving in nature and both rich and complex in its solution-finding. It should also be engaging, relevant and delivered at the point of need. While these demands are challenging, the solution should invite engagement and deliver the learning that is needed to boost confidence and counteract the inherent cognitive dissonance of writing a thesis. This can be achieved through incorporating a discussion/question-based approach, such as the Harkness method, ensuring that the learning is playful, social and consistently positive and that it uses a multi-sensory approach that is itself nuanced. The originality of this research lies in its conceptualisation: drawing multiple threads together to create a new solution, designed specifically to meet this very particular cohort's needs, in partnership with the EHDRS themselves, as illustrated in Figure 2.7.

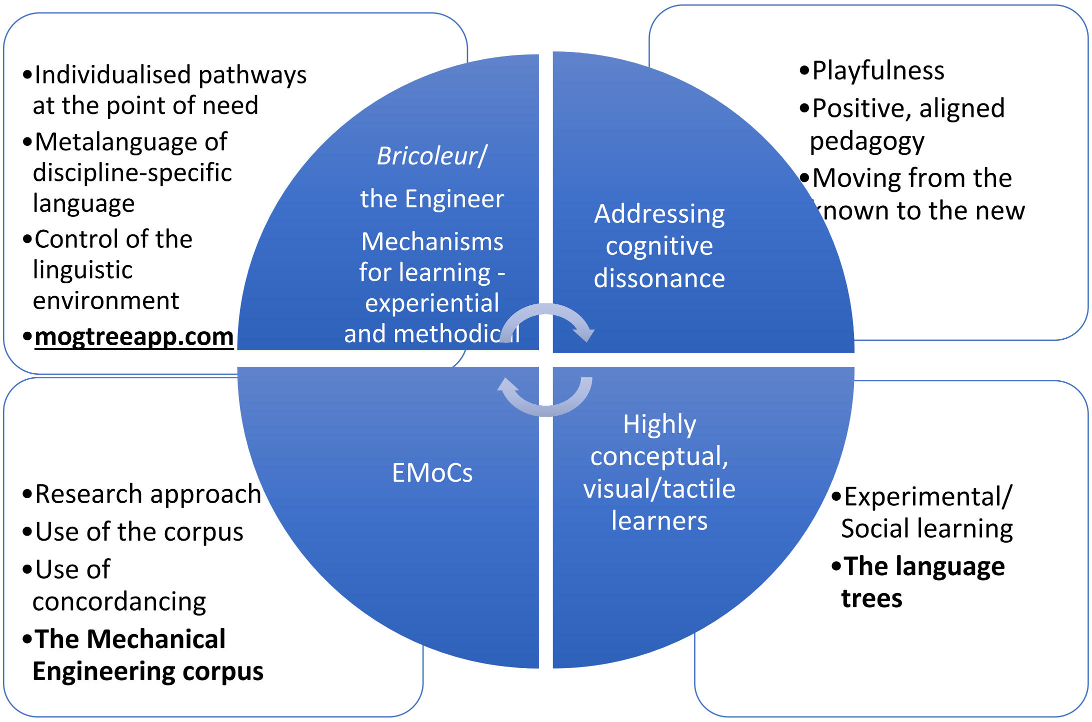


***Figure 2.7:* Human-centric solutions to the gaps and drivers, enabling and accelerating nuanced, academic writing for EHDRS**

Following this research into the elements of learner needs, learner modes of cognition and learner affective needs, alongside, pedagogy and praxis, it was possible to hypothesise a solution that would address the needs of all stakeholders and gatekeepers.

Having researched the foundations of the gap and set up the pedagogical and theoretical frameworks for the research, it was possible to set the foundations of the data: the needs analysis (Table 3.2, Appendix 4) and the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5), from which each spiral would develop, iteratively.

Chapter 3.
Spiral 1: The Discovery Workshops

3.1 Discovery Workshop 1: The Needs Analysis

3.1.1 Introduction

This chapter reports on the initial workshops, which are designed to set and negotiate baselines in learning and teaching, practice architecture and the actual needs of the EHDRS. The starting point, therefore, was to invite the students to analyse what they feel they need in terms of language support, in order to produce a positive, supportive, systematic approach to language learning. The opening and only question for the needs analysis was "*What support do you need with your language skills?*" (Appendix 4) (as per Huddlestone & Pike 2016).

Whilst a representative number of domestic and international participants with diverse language backgrounds were sought, this proved challenging to achieve in practice. In order to have sufficient numbers, those who agreed to attend were those who were involved. The participant group did not remain stable throughout the period, as a number felt that their engineering work took priority over language skills development. This was a common thread throughout the process, to which the analysis returns. Recognising and working alongside this issue is part of the ethical nature of the research, reinforcing its validity.

According to the ACED (Australian Council of Engineering Deans, 2017), the numbers of EHDRS has grown over the past ten years in the following proportions (Table 3.1). Notice that the balance of numbers of domestic and international students has changed significantly over the past ten years. Currently, international students outnumber domestic students at both Masters and PhD levels, which is a huge change across the past decade.

Table 3.1: ACED HDR numbers 2005-2015 (Australian Council of Engineering Deans 2017)

Award	**2005 Domestic**	**2005 International**	**2010 Domestic**	**2010 International**	**2015 Domestic**	**2015 International**
PhD	452	185	474	318	603	656
Masters	133	75	99	97	108	121
Totals	585	260	573	415	711	777

Table 3.1 highlights that the picture of language need has changed significantly over the past ten years, with the numbers of International students now outstripping the domestic students significantly and increasing by more than 300% over the period. Even this table masks another level of need: within the domestic group will be a significant number of bEAL/D students and a proportion who have taken citizenship prior to entry to HDR programs, who therefore are not accounted for within these numbers. Indeed, it can be argued that these students may well be invisible until they come to write, which is usually the first time that their language challenges can be seen, as their spoken English may well be of an equal fluency to that of L1 speakers of English (this is a hallmark of b(EALD)). These issues were reflected in the group of participants with whom I worked.

Whilst I have sought detailed statistical information on language origins of EHDRS from my own university, the only national level data available was provided by the ACED (Table 3.1). This suggests that data on language need are not held centrally and disseminated to Schools and Faculties, preventing tracking of language needs.

The self-selected group with which I worked in Spiral 1 comprised of a maximum of sixteen students, ten EAL/D, two L1 speakers of English and four bEAL/D. L1 English speakers were included for balance because they were sufficiently interested in the project to attend and were aware of issues with their own writing.

3.1.2 Reviewing the format: taking a qualitative approach in a quantitative discipline

A qualitative approach is used here because of the humanistic nature of the research. It evaluates emotional responses ("*How do you feel about…?*") and relies on questions instead of hypotheses (Cresswell 2008, p.106). Thus, the Product Workshop uses a 7 point Likert scale to measure responses, seeking broad agreement over empirical results. The use of a 7 point Likert scale for individual, behavioural responses is supported by Hair et al (2010) as particularly effective for this type of small-scale quantitative research.

One of the key elements of the research is that it proposes a solution and potential outcomes: it cannot disestablish and test all the variables, including the value and impact of the researcher as teacher, hence the focus on correlative outcomes. This is acknowledged as an inherent issue in educational research (Bennet 2013); however, it is part of the nature of educational research and should not be dismissed as devoid of use as it falls clearly into the field of action research. Thus, the powerful links between affect and humanistic vision are examined and explored within a highly evaluative research framework.

3.1.3 Affect and humanistic vision

del Carmen Salazar (2013) opens her discussion of pedagogy with this anguished prologue:

"I went to school with all of my treasures, including my Spanish language, Mexican culture, familia *(family), and ways of knowing. I abandoned my treasures at the classroom door in exchange for English and the U.S. culture; consequently, my assimilation into U.S. society was agonizing. One of my earliest memories is of wishing away my dark skin; I wanted desperately to be White, and I abhorred being* la morena*, the dark-skinned girl. I came to associate whiteness with success and brownness with failure. I was overwhelmed with feelings of shame over the most essential elements of my humanness. As a result, my experience in the U.S. educational system was marked by endless struggles to preserve my humanity."*

This statement of affect (emotional impact), along with all its kindred, unspoken echoes of an alienation that is inherently cultural, ethnic and linguistic, is commonly felt, if rarely as elegantly expressed. The notion of this self-hood being "treasure" is powerful; linking identity, self-efficacy and learning. It resonates with Reinharz (1992) and Rogoff's (1998) pleas for the use of the unstable first-person voice, I, representing the subject, the individual, the reader articulating the voice and the researcher in qualitative research and it reflects the focus of the humanistic approach, the participants being fully at the centre of the research. This group-orientated, intersectional approach (Choo and Ferree 2010) is the ethical outcome of the research and gives rigour to the claim that the work is grounded in a humanistic approach.

People have feelings and the learning and teaching community is becoming ever more aware of these feelings. Forms and levels of depression are increasingly recognised as common amongst adult learners, as well as young children, and amongst researchers in particular. As far back as 2006, a systematic meta-review of the data was completed by Dyrbye, Thomas and Shanafelt (2006 p.361) showing that the level of distress amongst high achieving students is “strikingly high”. In a more contemporary paper, Pain (2017 p.1) puts the prevalence of having or developing depression or similar at one third of the cohort. The survey undertaken suggests that over half of the respondents had had at least two symptoms of low well-being and 32% had experienced at least four, indicating an exceptionally high level of risk for psychiatric disorders. The control group contained a parallel cohort of highly educated adults, who experienced half this level of symptoms. This reinforces the idea that language is inherently social in nature and learning is a socially-located activity. From a humanistic perspective, then, it is vital that sensitive, positive, well-being approaches are built into any solution to the linguistic issues, as the cognitive dissonance at the core of feelings of socio-linguistic alienation will be particularly acute for EHDRS. This affective perspective is built into the pedagogical frameworks of the learning and teaching cycles of the participative action research, as well as the prototypes, products and analysis of the MOG TREE solution.

3.1.4 Needs analysis informing pedagogical practice in the Workshops

An affective, EMoC-orientated approach aligns with language learning, due to the cognitive dissonance experienced by the EHDRS in terms of the skills required for writing and those required for engineering. This discussion links and supports the findings of the needs analysis (Table 3.2 and Appendix 4) and the analysis of the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5).

An evaluation of the strengths and weaknesses of current language learning and teaching was made to show how the new product that evolved as a consequence, the MOG TREE system, would articulate with and transcend practice to date. This includes evaluation of current pedagogical frameworks and how they could be adapted for this particular group of learners.

It is clear that there are specific catalysts for learning available to EHDRS, exemplifying the work of researchers such as Gagné (2002) and Vygotsky (1978). This section incorporates a discussion of the need for high concept/abstraction learning to show respect for these exceptionally successful adult learners. EMoCs are discussed, defined and evaluated, locating affect centrally, as a core element of this human-centric engineering approach, as key catalysts for accelerating learning.

An evaluation of the concept of playfulness, as defined by researchers such as Brabazon (2016) is offered to enable both engagement and deep learning. This affirms the need for the positive alignment of pedagogy and praxis; moving from the known to the new by designing or utilising available designs of meaning (Cope and Kalantzis 2008, p.11).

The interim summary continues to link ideas and findings back up to the needs analysis (Table 3.2, Appendix 4), writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) and theoretical framework of the research. From this, a complex, nuanced, tri-partite solution to this complex, nuanced issue is proposed.

3.1.5 Analysing the data

Some of the discussions, particularly with the EAL/D students, were heartbreakingly honest: many felt let down by the system and equally ill-prepared for their studies by their previous work. This, however, was broadly true across the participant group, regardless of language background. The students were also very clear that cultural knowledge is bound up in linguistic knowledge, control and understanding: that is, that it is social in nature. Whilst this driver is then subordinated by academic and discipline language need, it remains a constant, which certainly fits with a humanistic approach to language, learning and teaching (Lakoff 1973).

The outcomes of the discussions were very clear and followed four, equal, key lines of enquiry:

- The need for help at word and phrase level
- The need for help at genre level
- The need for consistency and clarity of requirements across the School
- The need for greater understanding of and help for L2+ students, at both language and social/cultural levels.

The students perceived that they had three critical levels of specific language need:

- Greater control over genre
- Greater control over word form
- Greater control over word order.

Thus, the summative dot points above show that the English for academic purposes orientated, genre-based workshops are clearly necessary but not sufficient as they do not specifically focus on word form (grammar) and meaning-making (semantics). A more grammatical, structural set of supports is also required. The students perceived these needs as essential.

There was a high frequency of discussion about the need to control grammar, but most then auto-corrected to see grammar as being needed in context, that is, in the social environment of language use, or nuanced academic English. By segregating the levels of language (linguists would add in phrase level), the students showed remarkable perception of their own difficulties.

Two responses were summative: *"Tell us the grammar we need to know when we need to know it"* and *"I'm frustrated that I can write perfectly grammatical sentences and I'm still criticised for not sounding like I'm writing in English"* (Participant 009). The first pertains to the pedagogy of teaching: that it needs to be accessed at time-critical moments, and the second to the social context of language or social fluency. The solution, therefore, needed to hold both of these issues as central. This also suggested that a mono-focused solution would not be sufficient for the complexity of these students' needs.

It was also clear that the method of delivery would be critical: it had to support the affective needs (including academic and emotional pride) of the students, so that they retained their sense of self-efficacy and positivity in terms of the act of writing.

Once the workshops had been framed from a theoretical perspective and the questions, data gathering instruments (group discussions, individual question and answer sessions and Likert scale questions at the end) and participant group established, the data were gathered for analysis. The EHDRS' answers to the needs analysis (Table 3.2, Appendix 4) underpin the analysis of the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5). The writing samples confirm the EHDRS' responses to the needs analysis. In this way, the spiral approach is affirmed as effective, as the links forwards, backwards and across the research data types and Discovery workshops are fluid and supportive each of the other. The fluidity of the links in the Discovery workshops is then further reflected across the Prototype and Product workshops, which refer back to, respond to, analyse and answer questions raised throughout the research process.

Fluidity, therefore, is a hallmark of both the research methodology and the research outcomes, enhancing the integrity of the research as a whole.

The data gathered in the needs analysis (Table 3.2) shows three key areas for discussion: skills in English for academic purposes and grammar, as well as whole School (that is, School culture and learning and teaching) issues. The skills and issues break into three parts: those which need to be addressed through English for academic purposes and grammar, those addressed through grammar alone and those which are whole School issues. All the following issues were raised by at least one student in the group and, as this was a discussion with field notes written by the researcher and the students, agreed by the group as having significance. It is therefore raw data. The notes to the left are the researcher's classification notes and to the right are proposed solutions to the issues summarised from the students' suggestions.

Table 3.2: Issues and skills raised by the participants in the introductory meeting.

Issue	Most appropriate learning and teaching approach
Accurate description, clarity, accuracy of expression, storytelling, fluency, cohesion, being concise, clear communication skills	EAP and Grammar
Formatting figures, reports, articles, equations, etc.	EAP and Grammar
Pre-planning and layers of planning of the structure of a proposal, journal, lit review, report including ability to identify what to include/exclude and transfer this to meaningful, effective writing	EAP and Grammar
Differences between genres e.g. lit review and review article	EAP and Grammar
Learning how to write a Core Component of the Structured Program (CCSP), Major Review or Annual Review according to a School style – multiple supervisor comments can multiply confusion	EAP and Grammar
How to speed up writing	EAP and Grammar
Negotiated writing with the supervisor, so it is marked for ideas or accuracy, but not both simultaneously	EAP and Grammar
The need to be use dot points for idea generation and to clarify the order of points	EAP and Grammar
Spelling	Grammar
Structure and grammar – grammatical accuracy	Grammar
Keeping within word limits	Grammar
Sentence and paragraph level expression and clarity, managing sentence length	Grammar
How to write stylishly	Grammar
Ability to self-edit	Grammar
Early writing interventions before the CCSP	Grammar
Need for a School Proforma for CCSP, Major Review and Annual Review	Whole School issue
Reassurance that the writing has validity	Whole School issue
A system of alerts so that those with strong writing needs know how to get help early on not just that they need it	Whole School issue
Greater understanding of L2+ English speakers, including some separation for some learning so it can be done at the right pace and with understanding of the cultural issues to do with language that L2+ speakers face	Whole School issue
More access to editing help	Whole School issue

Clearly all these needs should be addressed wherever possible within the new approach to learning and teaching of L1 English skills. It was also very clear that the participants felt that their cultural needs were being ignored by the university training systems (notably supervisors and CaRST courses) in terms of learning and teaching doctoral writing skills. Thus, the needs analysis (Table 3.2, Appendix 4) was integrated with the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) to generate an holistic solution to the question: "*What support do you need with your language skills?*" (Appendix 4).

3.2 Discovery Workshop 2: the writing samples

Having engaged with the needs analysis (Table 3.2, Appendix 4) using the process "Embark and Clarify", (Figure 2.2), and established the format and delivery of the workshops so that they appealed to the EHDRS, it was necessary to "Find and Generate" (Figure 2.2) baseline data.

In order to do this, the participants were invited to attend a workshop and write a 200 word journal-style abstract. This meant that the language being asked for should be familiar, comfortable and have an (also familiar) inherent structure. It also meant that the language should be academic in nature, as the students are at least three months into candidature. All the initial respondents (n=16) (Table 3.1) engaged with this task across three instances of the workshop (the workshop protocols were identical but arranged at times that were more accessible for individual students).

The writing samples were all handwritten (then copy-typed for anonymity and annotated for analysis of the error types, Appendix 5), so that spelling and grammar checkers would not mask the EHDRS' errors. Writing about a familiar topic, in a familiar form, (that is, familiar research in the form of an Abstract) ensured that there was no anxiety about the nature of the writing, that it fell within the scope of engineering writing and that the students could focus on the writing itself, as the content was already familiar to them. The suggested length was 200-300 words in a familiar, journal abstract form. All sixteen of the original participants undertook this task. The participants were offered up to an hour in which to write and were allowed to leave the room when they were happy with their writing sample. The types and instance frequency of the errors found in the writing samples are shown in Table 3.3, along with types of remediation that would offer support to the EHDRS.

The samples were then typed up and annotated. Many of the EHDRS expressed frustration and some disbelief with their own errors, indicating a lack of self-editing skills and foundations for potential emotional reactions to writing tasks. The full, typed, annotated samples are to be found in Appendix 5.

The error types were grouped into 28 separate elements which form the basis of accurate, nuanced academic writing and are shown below (Table 3.3), grouped according to their error type and level (that is, word, phrase, sentence and whole text levels), to match up with the needs analysis identifications (Table 3.2).

Table 3.3: Identification of error frequency and type in the baseline writing samples at word, phrase, punctuation, sentence and genre levels

Word Level		**Error Frequency**
1	Missing articles/article error	21
2	Preposition choice	8
3	Spelling errors	29
4	Word choice	4
5	Word form	13
6	Weak modifier	1
Phrase Level		
7	Missing words/phrases	3
8	Split infinitives	2
9	Verb form	7
Punctuation Level		
10	Hyphenation of compound words	3
11	Punctuation errors/misused full stops or commas	48
Sentence Level		
12	Overuse of simple sentences	1
13	Unclear subject	3
Genre Level		
14	Cohesion issues	4
15	Copied, not planned	1
16	Google translate used against instructions	3
17	Missing information	3
18	Missing key words	16
19	Missing title	15
20	Missing topic sentence	3
21	Non-standard English	38
22	No plan at all	16
23	Numbering issues	14
24	Poor logic	3
25	Use of bullet points instead of prose	2
26	Use of first person	3
27	Voice	5
28	Wrong topic	1

At the simplest level of interpretation, Table 3.3 would support the contention that the identification of language problems by the EHDRS in the needs analysis (Table 3.2, Appendix 4) was accurate and helpful, and they were fully aware of their needs, which were not being met sufficiently through current language teaching practice. The levels of error types fall into patterns that could be used to tackle language grammatically, as well as at whole text levels, suggesting a multi-level or tri-partite solution was necessary. The error types can be reclassified to generate solutions, as outlined in Table 3.4.

Table 3.4: Error types from the writing samples, leading to prototype solution approaches: the three broad solutions are the physical-tactile, visual-spatial solution (PTVS), the collocation tool (CT) and the synergetic systems engineering tool (SSE)

Error type	**Instance frequency**	**Form of remediation**
Word form	13	PTVS, CT, SSE
Missing/erroneous article	21	PTVS, CT, SSE
Verb form	7 (more in the non-standard English phrasing count)	PTVS, CT, SSE
Non-standard English phrasing	42	PTVS, CT, SSE
Number issue	14	PTVS, CT, SSE
Google translate used	3	PTVS, CT, SSE
Hyphenate compound words for clarity	3	PTVS, CT, SSE
Split infinitive	2	PTVS, CT, SSE
Spelling	29	Dictionary
Completely missing topic sentence	3	PTVS, CT
Missing title	15	PTVS, SSE
Punctuation errors	48	PTVS, SSE
Voice	5	PTVS, SSE
Missing words/phrase	3	PTVS, SSE
Cohesion issues	4	PTVS, SSE
Use of bullet points	2	PTVS, SSE
Wrong topic	1	PTVS, SSE
Missing information	3	PTVS
Unclear subject	1	PTVS
Weak modifier	1	PTVS
Poor logic	3	PTVS
Copied not planned	1	PTVS
No plan	16	PTVS
Preposition error	8	CT, SSE
Use of first person	3	CT, SSE
Missing key words	16	SSE

The results in Table 3.4 clearly show a need for refined, targeted solutions, hence the choice to build a tri-partite solution that could be moulded to fit individual needs for specific learning instances. The tri-partite Prototype solution is therefore geared to generate a multi-level set of articulating approaches, where facets can be used either individually or holistically to generate individualised pathways to answers.

The process of identification also confirmed the gap in the knowledge of language identified as central to this thesis (that is, familiarity with and mastery of nuanced, accurate academic language) and the need for a new solution (or set of solutions) to authentic writing issues amongst this particular group of learners. The approach is grounded in extant research practice but has originality in its conceptualisation of an holistic solution, which draws together threads from a range of learning theories to generate a new solution to the particular needs of this particular set of learners: postgraduate engineering students.

It is also interesting to note that the L1 students share many of the language needs of the bEALD students. It became obvious over the course of the research that that is the difference between the learner groups lies in the degree and speed of remediation of the identified issues of those who are L1 speakers of English and those who are bEAL/D.

3.3 Results: Using the data to create solution(s)

Once the broad needs of the students had been identified through the needs analysis (Table 3.2), the EHDRS' error types in the writing samples were re-analysed (Table 3.3) to generate potential Spiral 2 Prototype solutions:

1. A physical-tactile, visual-spatial language learning system (PTVS)
2. A concordancing tool (CT)
3. A synergetic systems engineering approach (SSE).

At Product level, in Spiral 3, these prototype solutions then became:

1. The language trees
2. The Mechanical Engineering concordancing tool
3. The http://www.mogtreeapp.com grammar tool

These needs were confirmed by the EHDRS in the focus group discussions as accurately reflecting their views as well as the evidence, in detail and in big picture. Interestingly, punctuation was a significant issue that clearly needed to be addressed within the solution, even though it is not normally addressed within either a grammatical or a genre approach. Punctuation was therefore included in parts of the solution in order to respond holistically to the EHDRS' needs.

The data were then used to drive the development of the tri-partite solution, starting with the physical-tactile, visual-spatial learning tool, which evolved into the language trees solution.

3.4 Conclusion

For this research, this group of informed, articulate EHDRS, drawn primarily from the School of Mechanical Engineering, but also including a small group from related Schools within the Faculty of ECMS at the University of Adelaide, provides a coherent community of learners for a case study (Cohen, Manion & Morrison 2013, p.289) of the issues surrounding the learning of nuanced, academic English.

The case study approach is used to give authenticity and rigour to the findings, locating the work in an authentic social context (Cohen, Manion & Morrison 2013, p.289). It also underlines the humanistic nature of the study, as it focuses on authentic, human needs at an affective, as well as an academic level (Simons 1996; cited in Cohen, Manion & Morrison 2013, p.290).

The use of the Spiral 1 needs analysis (Table 3.2, Appendix 4) and the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5), and the drawing together of internally consistent threads of need with baseline and developmental data, is designed to reduce bias within the research, which is given external validity through the use of methodological reasoning grounded in extant research and internal validity through its own internal cohesion. Concurrent validity is achieved through the use of multiple sources and triangulation of perspectives and instruments used (Cohen, Manion & Morrison 2013, p.295). Thus, the research follows extant qualitative research methods, notably participative action research, aligned with the engineering method, to ensure consistency, authenticity and rigour in a synergetic systems engineering approach.

Participative action research is an approach based on empowerment and emancipation, thereby aligning with the humanistic philosophy and enhancing engagement with the process of idea and solution generation. It supports research that starts with small groups of participants and builds evidence of practice, theory and reflection in an ethical way (McTaggart 1989; in Cohen, Manion & Morrison 2013, p.248). It is designed to remediate issues and enhance engagement as per Friere (1972; in Cohen, Manion & Morrison 2013, p.348). Thus, it is inherently social in nature, recognising this community of practice within its School, Faculty and University structures, and includes both the academic and the affective in its scope. Simultaneously, participative action research spirals, the design and redesign, iterative process of investigation employed here, mimic an experimental or systems engineering approach, as layers of knowledge unfold, expand, are reviewed and redesigned until they become established within the community of practice in the School of Mechanical Engineering at the University of Adelaide. Participative action research, as explored in this case study, is also emancipatory via its humanistic and affective drivers (Kincheloe 2003; in Cohen, Manion & Morrison 2013, p.349).

Unanticipated results, which challenged the research, were welcomed as they offered a strengthening voice of anti-thesis. Through this seeming negativity, systems health management or systems resilience is built into the research, which fully acknowledges, recognises and redesigns alongside such antagonistic elements and outcomes (Johnson 2014; in Rainey 2015a, p.131). Thus, in this research, it is the very resistance of a significant number of the EHDRS to putting time into learning what they acknowledge they need in terms of language amelioration and refinement, which supports, problematizes and enhances the proposed solution(s). The correlative approach used in this early research is qualitative in nature as it focuses on emotional responses, or human-centric learning practices.

Chapter 4.
Spiral 2: Designing and Testing the Prototypes

4.1 Introduction

This chapter presents the experimental solutions to the issues raised in the problem statement and confirmed through the three Discovery Workshops. The first of these workshops explores the development and initial use of the physical-tactile, visual-spatial language-learning tool, which was to become the learning tree. The second explored the first prototype of effectively engaging the students in corpus linguistics. The third considers a grammar tool, based specifically on the types of grammar needed by postgraduate engineers, with all the examples taken from authentic engineering examples.

4.2 Prototype Workshop 1: The Language Trees

4.2.1 Introduction

A physical-tactile, visual-spatial language tool is the first part of the tri-partite solution and meets the need for highly conceptual, social, physical-tactile learning processes. The purpose of the tool (which was to become known as the language trees at product level), is explained in terms of the theory developed in Chapter 2 and the alignments are clarified. Alignments are made with engineering modes of cognition (Engineers Australia 2014), gifted and talented education (Gagné 2012), play theory (Brabazon 2016) and the needs analysis (Table 3.2, Appendix 4) and writing samples (Tables 2.2, 3.3, 3.4, Appendix 5).

An outline is presented of the development of the design of the language trees, the data collection questions, methodologies and developments made in the light of participant and workshop comments. Data from Spiral One are considered to analyse the potential strengths of the solution and revise its outcome. The material is then evaluated for its limitations. Unmet needs are considered in detail in order to achieve the nuanced solution sought. Suggestions are made about the potential of the solution, its strengths, weaknesses and limitations.

The MOGTREE System is designed to be as positive an experience as possible, as there is a risk of the teaching reinforcing complex, negative emotions about the imposition of an alien language and culture if it is not created, structured and delivered effectively. However, it is clear from the students' comments that they wish to learn English in order to achieve the best learning outcomes possible during their postgraduate studies and build their careers. For me, this was a powerful echo of an earlier teaching experience when undertaking a study tour overseas.

Personal Reflection

This echoes a deeply human pedagogical moment when I was teaching in and around Durban, South Africa. This moment created a paradigm shift in my thinking about learning and teaching. I had been invited to visit a tree school (literally a school held around a tree, rather than in a building) to consider teaching pedagogy with their staff, as they had no trained teachers and several gifted students. They were looking for support. As the lead teacher in charge of the gifted program at my school in the UK (as well as the lead teacher for the school district), I was invited in an advisory capacity through the Teachers' International Personal Development (TIPD) program running at the time.

To my infinite joy, I was invited not only to observe, but to share a lesson with the students. The children chatted to me enthusiastically and asked what I taught. When I said English and French, they asked me to teach them some songs in French (moving from the known to the new (Cope and Kalantzis 2008): the children were amazing singers). I was surprised as it seemed so far from relevancy for a class of children in the African bush (their teachers were teenagers who had outlived primary education and most of the adults who had taught them), a significant proportion of whom had HIV infections and were unlikely to have long life expectancy, given the paucity of access to the needed medical support (the average life expectancy in KwaZulu Natal overall was 45.7 years for all those born between 2001 and 2006, however this group of students had little access to city hospitals and medicine, and the rate of HIV infection at the rural school was particularly high (Statistics South Africa 2014)). It seemed to me that there must be more important things to learn for these wonderful humans. "*Why not?*" they asked, disappointed when I demurred, "*Aren't we good enough?*" It was a powerful lesson: by trying to meet them in their world, I was actually denying them access to mine. Needless to say, we sang French songs for the rest of the day and learnt some key conversational phrases just for the pleasure of learning.

It was a huge lesson for me: where I had seen irrelevancy, colonial oppression and negativity, the children saw a unique opportunity to learn. So too my postgraduate students acknowledge the oppression of English language learning but simultaneously wish to enter fully into the English language learning community. (Participant 003: *"It's not that I want to learn English, but I want to achieve in the world, so I have to learn it and I will, even though sometimes it makes me angry as I speak a perfectly* *good language already*.”) For me, it is the same as for the African children: the EHDRS are just further on in their dreams and have (far) greater life opportunities.

4.2.2 Language and learning

The focus of the research is a particular subgroup of EHDRS. As a group, there is some evidence that they are very physical, tactile learners (Engineers Australia 2014). When they were asked during each workshop across the three spirals how they identified as learners, there was 100% agreement that engineers see themselves like this and, indeed, see it as one of their unique identifiers as a learning community.

This form of self-identification is repeated consistently across discussion groups of engineers from undergraduate to the highest postgraduate levels. Indeed, engagement was significantly enhanced when the rationales for each element of the MOGTREE system were shared with the students, as they recognised the thinking as familiar. Unlike many other students in other disciplines, EHDRS are trained to deal with objects such as digital instruments and ideas explicitly. As learners, they are both highly conceptual and physically creative; this is both reinforced by and part of their high level of intelligence (Gagné 2012).

It is academically demanding to gain access to an Engineering degree: entry requires one of the highest tertiary entrance rankings in the university (minimum entry level 80 or top 20% (Adelaide Approved 2018) of those taking secondary terminal examinations). So, these learners can be defined as likely to fall into the gifted spectrum, with a strong affinity for academic learning, or they would have moved straight into industry or Vocational Education Training (ASQA 2018). The EHDRS have already completed undergraduate studies of some three to five years, depending on their country of study at undergraduate level, and many have completed some training in industry before entering postgraduate study, suggesting they have all moved significantly through the 10,000 hours required to move from gifted (a natural aptitude for learning) to talented (an expert in a field), as defined by Rose (2013).

Gagné (2012) has shown (Figure 2.7) that gifted students are typically very conceptual in their approach to learning and it has been argued (Rose 2013) that their talents have taken some 10,000 hours of purposeful practice (Gross 2005 p.26) or task-focused learning to develop (Sloboda et al 1996). Felder and Silverman (1988) explain that gifted students are systems thinkers, and this is evidently true of EHDRS who are challenged by new subjects, cross curricular thinking and high stakes examinations to develop their gifts into crafted talents in terms of engineering. Thus, the EHDRS can be characterised as learners who also have the key academic learning traits of resilience and determination. One of the design features, therefore, of the language trees is that they enable a systematic approach to language learning, which supports affect (emotional responses) through engagement, support and playfulness.

4.2.3 Development of the Language Trees

The conceptualisation of physical-tactile, visual-spatial language learning tools are solidly grounded in established educational theory and practice. The attributes of existing tools were therefore initially evaluated for inspiration in designing an adult based tool that would inspire EHDR students.

4.2.3.1. **Montessori language learning**

The first characteristic that led to the design of the language trees was drawn from Montessori language learning theory and practice. Montessori's language blocks (Figure 4.1) are used to stimulate imagination and creativity in young children.

Figure 4.1: Montessori Blocks (absorbentminds 2018)

The Montessori system was created in the 1950s and has been proven over many years to make a statistically significant difference to language arts, vocabulary and reading comprehension development for those who have received at least one year of teaching via this methodology. Much of the reporting of Montessori schooling is anecdotal or informal, however Peng (2009) investigated these differences formally as part of a PhD thesis.

The results of the formal testing show that whilst the difference in language development is statistically significant, the same improvement is not replicated for maths and social sciences, but the differences for language are notable. Although the language results for Montessori trained students are consistently higher than for non-

Montessori trained students, it is only in these language-based areas that the difference is statistically significant via broad-based testing. The trend for this difference extends with greater exposure to the Montessori training method (Peng 2009 pp.108-110).

The Montessori system invites the child to select their own pace of learning from specific stimuli that are common to all Montessori schools. Thus, it is inherently a self-motivating system of learning and teaching, which moves from the general to the specific. This is very attractive as an approach to learning and teaching, as it is echoed when teaching the EHDRS. Montessori word blocks (Figure 4.2) are made from wood that can be twisted to create individual words. This is an attractive, organic material that has an allegorical link with the organic approach to language that is being sought.

Figure 4.2: Montessori Word Blocks (etsy 2018)

4.2.3.2. **Areaware Blockitecture**

The second source of inspiration was Areaware (Areaware.com 2016) architectural blocks or Blockitecture (Figures 4.3, 4.4 and 4.5). These blocks tessellate to encourage creative building. They are also beautifully designed, elegantly crafted and encourage creative play, which aligns with both EMoCs and play theory. The blocks are sold as conceptual educational toys for both children and adults. They can be used to explore and replicate the world, or to generate design ideas for living. The blocks are made of wood and painted in subtle colours to encourage sustainable design thinking. The use of colour was interesting and became a strand in the final conceptual design of the language trees.

The Areaware architectural blocks facilitate the conceptual and physical move from a 2D concept of language learning to a 3D object, ready for the innovative design process. The blocks come in a variety of designs and can be used in their original groupings as sold, or mixed together to form variant types of architecture. They are themed by both shape and colour, supporting the use of colour as a pedagogical theme.

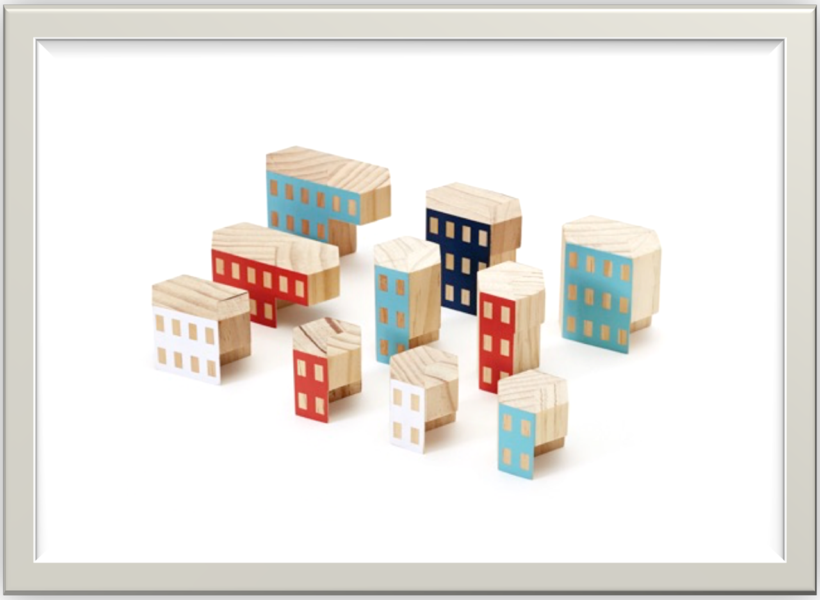


Figure 4.3: Basic Areaware Architectural Blocks (Areaware 2016)

Figure 4.4: Areaware Blockitecture in action (Areaware 2017a)

Figure 4.5: Blockitecture Garden City (Areaware 2017b)

4.2.3.3. **Cuisenaire rods**

The final design element comes from the Cuisenaire rods (Chambers 1964) (Figure 4.6) through which many now in their 50s+ learned Mathematics as children. Cuisenaire rods use shape and colour to teach concepts, primarily, but not exclusively, in Mathematics.

Figure 4.6 Cuisenaire rods (discounttoyco n.d.)

The impact in one year of teaching by the Cuisenaire-Gattagno method is broadly comparable with that of using traditional methods: however, by year two, the students have not only learnt all the skills on offer using traditional methods but additional skills and confidence as well, increasing the learning gains significantly (Hollis 1965).

Hollis (1965) suggests both that the physicality of the learning is appropriate and successful and that continued use of the system is beneficial. Continued use will be a necessary element of the language learning process for the EHDRS: it is not a quick fix but engaging in a suitable pedagogy that is likely to be highly beneficial.

Eddy (1977) invited a group of modern foreign language teachers to use the rods for language development after intensive training. In the annotations to the teaching ideas offered in the book, teachers commented: “I believe this system can be used with any age language learner” (1977 p.6), supporting the use of a parallel system with EHDRS. The effect of the blocks is to invite the students to “participate in learning fun” (Eddy 1977 p.6). Another opportunity is to engage in “cross-cultural understanding” (Eddy 1977 p.7). Again: “students react positively to the unit and gain useful vocabulary”

(Eddy 1977 p.18). The positive responses of the students to the physical-tactile nature of the learning, coupled with playfulness, are consistently viewed as leading to significant additional engagement in the learning, along with learning gains. These twin elements are critical to the purpose of the language trees, so it is appropriate to conceptualise the language trees with the Cuisinaire-Gattagno method of language rods in mind.

Thus, the use of a physical object in learning articulates with the EMoCs (Engineers Australia 2014), Play Theory and highly conceptual learning for gifted learners, which have already been shown to be powerful and effective methodologies for EHDRS. In this way, the language trees enable the movement from the known (or familiar) to the new (or unfamiliar) (Cope and Kalantzis 2008).

The colours and shapes of the Cuisenaire rods denote meaningful mathematical concepts and connections to the students (Figure 4.7). This highlights the advantages of the language trees' leaves carrying meaningful colour, assigned by the students to grammatical forms or elements of punctuation, to focus thinking on, for example, article use, order of noun phrases or use of punctuation for effect.

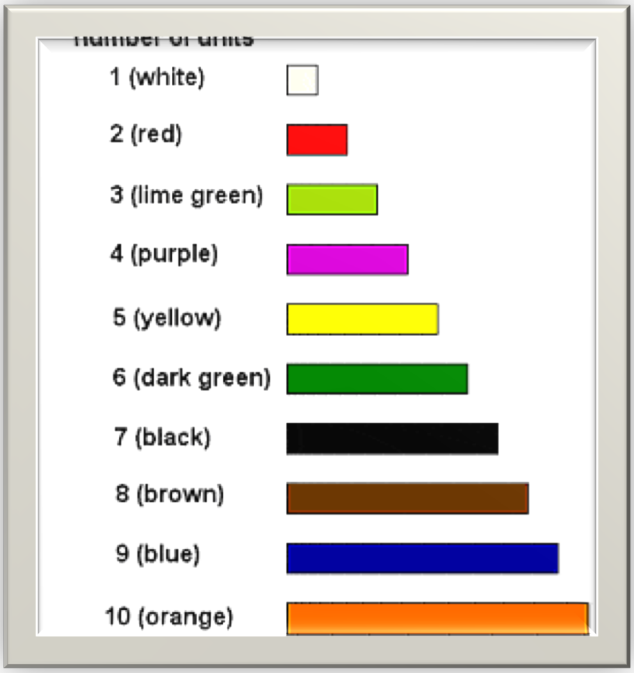


Figure 4.7: Mathematical meanings of Cuisenaire rods (Chegg 2018)

Figure 4.8 shows how the original Cuisenaire rods can and continue to be used for language development.

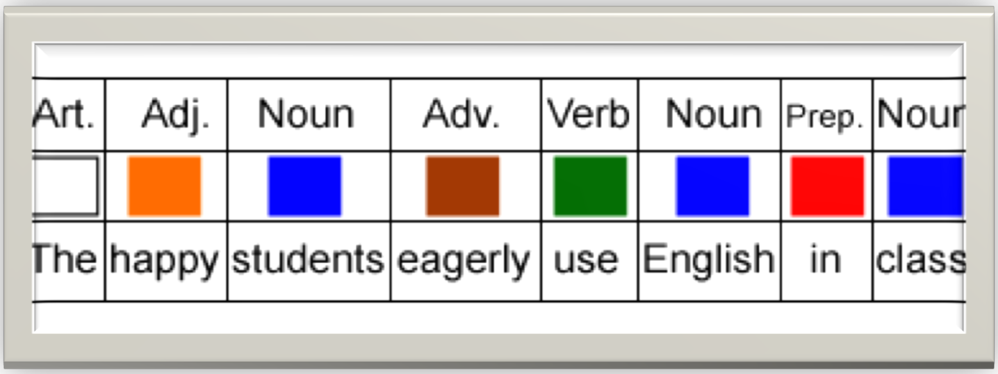


Figure 4.8: Cuisinaire rods used for word building (Commpartners 2018)

Thus, there is a clear, established precedent for using both colour and shape for teaching language directly.

4.2.4 The Design

Each of these approaches to learning and teaching (Montessori, architectural blocks and Cuisinaire rods) gives a strong pedagogical framework and capitalise on the observable construction and interdependent elements of language. However, the Montessori system, Areaware architectural blocks and Cuisenaire rods were designed for children and hence most likely to appear condescending to an EHDR student. The constructive attributes of these systems clearly require an adult alternative that motivates high-achieving adult engineering students from a non-English speaking background.

Synergetic Systems Engineering underpins the engineering design process (Chestnut, 1967) and considers the holistic perspective of a design problem, and how that problem might be deconstructed into interdependent sub-systems to form the whole. Clearly there are analogies here to the deconstruction (and hence construction) of language and writing, so there were seen to be clear benefits in developing an obvious systematic physical-tactile, visual-spatial language-learning tool that could easy relate to engineering problem solving methods.

After numerous brainstorming sessions with my engineering supervisor, a variety of tangible ways to visual and spatially represent the interdependence of language elements were considered that would be meaningful to an engineer. All were dismissed as impractical until finally the fundamental concept of a tree was selected. A tree may be deconstructed into multiple tiers of branches (each representative of a sub-system), and each branch can be adorned with leaves (components). The leaves in turn may be adorned with words; the branches consequently become sentences and multiple branches hanging from the trunk may then form paragraphs, hence the genesis of the language tree (Figures 4.9 and 4.10).

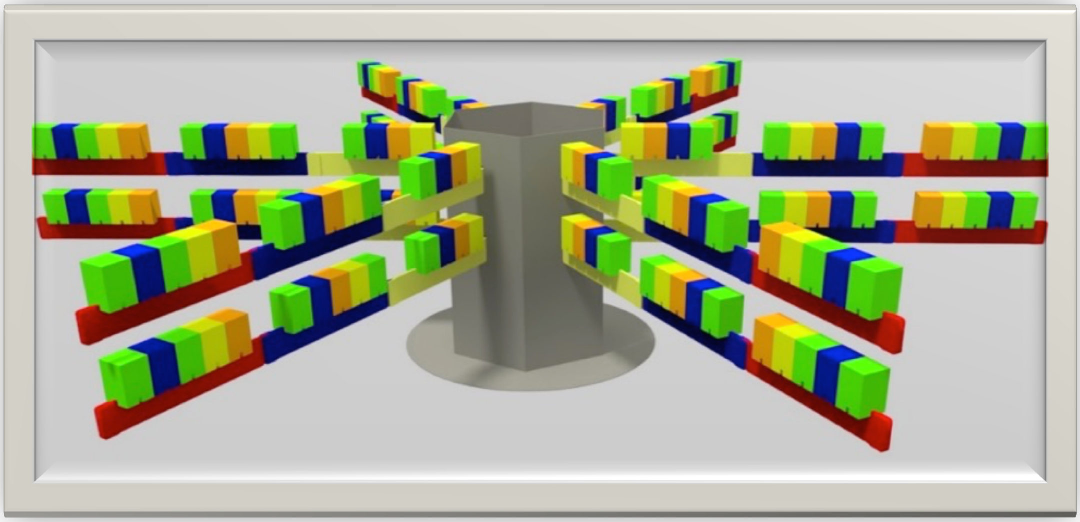


Figure 4.9:* *CAD rendering of the language tree

The concept of the tree attracted broad agreement between the participants in the workshop, the researcher and the supervisory team that the design would offer the most effective surface space for social learning. It would also work in harmonious analogy with language as an organic, complex structure, which can be shaped to suit a diverse range of specific purposes.

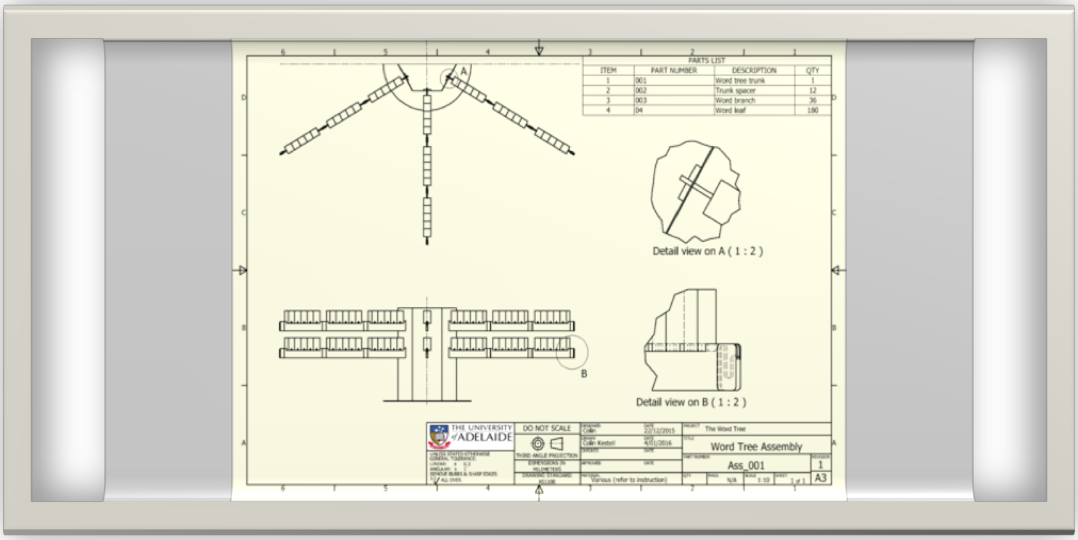


Figure 4.10 CAD drawing of the language tree

Various shapes for the trunk were considered in the workshops, eliciting the response from Participant 07: "*Make it a hexagon. Engineers love hexagons*.". Considering this, and also taking into account manufacture and operation, the trunk (Figures 4.11 and 4.12) became a hollow 25 cm wide hexagonal prism. While the tools considered previously primarily use timber, aluminium was chosen to be a more pragmatic choice for the language trees. Aluminium provided an industrial feel, avoiding the risk of it resembling a child's toy. The elegance of the design and materials has been commented on approvingly by some of the academics (Lecturer comment on seeing the language trees being moved around the School*: "That looks like real engineering. Very industrial."*), as well as having support from the EHDRS themselves. Furthermore, aluminium can be coated so it can be written on multiple times, with easy wipe-off. It is also lighter to carry and therefore far easier to move about to diverse learning spaces, re-build and take down. There are 150 leaves as well as 12 branches and the trunk, so ease-of-use is significant to ensure the language trees are a viable option to move to learning spaces and are usable when in place.

The trunk was coated so that it can be written on and wiped clean with white board markers for re-use, hence lending itself to drafting, which is its primary purpose.

Once the branches are attached, the trunk can be used to build sequences of up to six paragraphs at a time (one on each facet). This is sufficient to build a thesis section or the outline of a whole thesis. Used in groups, it is large enough to hold sequential ideas to build upon, which can be developed along the branches and leaves.

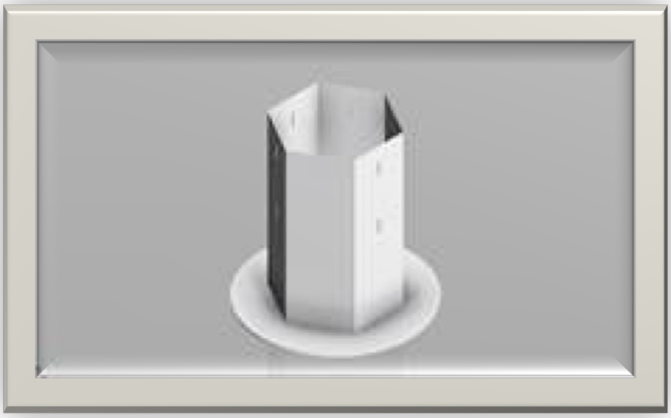


Figure 4.11: CAD drawing of the trunk

Figure 4.12: Manufacturing the trunk

The branches (Figure 4.13) were originally made of acrylic (Figure 4.14) but snapped during use with monotonous regularity; hence subsequent prototypes were made from aluminium. Originally, they were also designed to be written upon, but in the aluminium version the filigree design was used in place of free writing for aesthetic reasons. The branches are just over a metre in length so adults can move amongst the branches inducing natural social interactions. When they are in play (and the word is used deliberately), the whole group can move the language tree and sit in front of it to share ideas and drafting, or they can simply go and look at what other people are doing, comment and share ideas (Figure 4.15).

Figure 4.13: The final branch design

Figure 4.14: The original branches, made of acrylic, with raw (un-anodised) leaves

When the branches are attached there is still plenty of space on the trunk and leaves for noting and drafting. Montessori word blocks are used to generate early words for reading and writing, and may (Figure 4.2) or may not (Figure 4.1) have letters on them, so they are pre-built into words. There was much discussion between myself and my engineering supervisor about whether or not to pre-fill the leaves on the language trees with letters and words. Ultimately, this was felt to be limiting as, although it solved spelling issues and could be useful for vocabulary building, it simultaneously pre-determined the language field available. There are other ways to build vocabulary, notably through the reading practices that are inherent in research study. It was also impractical as the leaves were expensive and time-consuming to produce, so open blocks were selected in their place.

In some of the earliest iterations of the language trees, chalk paint was considered for use on the leaves to enable writing directly on the leaves, branches and trunk. However, it was felt by myself and my engineering supervisor that this would deny us access to the use of colour, so the idea was discarded during the planning stage. Instead, anodised paint was chosen: partly to protect the metal from corrosion and partly to enable writing using dry wipe-off pens, which are easily accessible for any classroom. Once the necessity for colour had been established through discussion with the EHDRS in the workshop, the original plan was to use eight colours to replicate the eight parts of speech, with overlapping colours to indicate phrase, sentence and genre level. However, the anodising process, limited these colours to four. Figure 4.15 shows the original colour availability, and Figure 4.16 showing those that were available in practice.

Nevertheless, The EHDRS approved of being given limited choices over the use and meaning of the colours. As Participant 001 reported in the Workshop: *"It's good that we can control this element and that the colours are limited. It means we have to think through our focus and draws our attention to it".* Thus, encouraging the students to make focused choices from a limited colour palette was ultimately far more beneficial for them, as it gave them control over the process, enforced language choices and kept a tight focus on the learning needed at any given moment, as per their requests in the needs analysis (Table 3.2, Appendix 4) (for example, Participant 009 in the workshop said: *"Teach us the grammar we need to know when we need to know it."*).

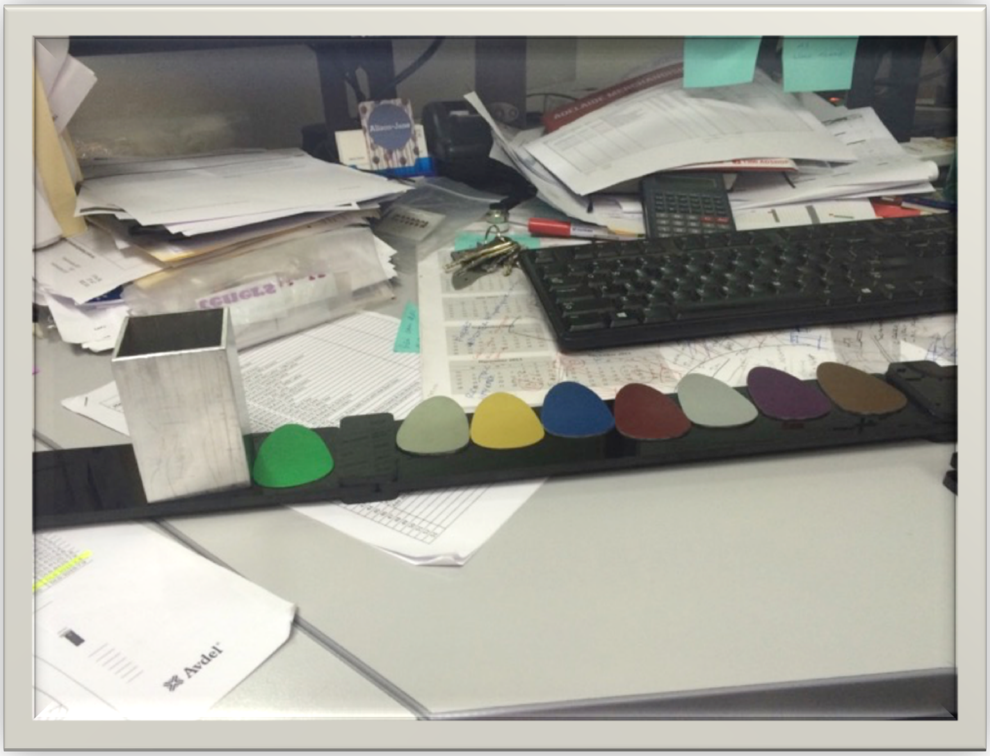


Figure 4.15: Selecting the colour palette from the original choices

Figure 4.16: The actual colour palette (orange and brown were ultimately unavailable)

The language trees approach language that is highly conceptual, structured and playful. These issues are all critical. The language trees are highly stylised, by definition (Figure 4.17). The intention was to use a very industrial design to give an adult, engineering feel to the structure.

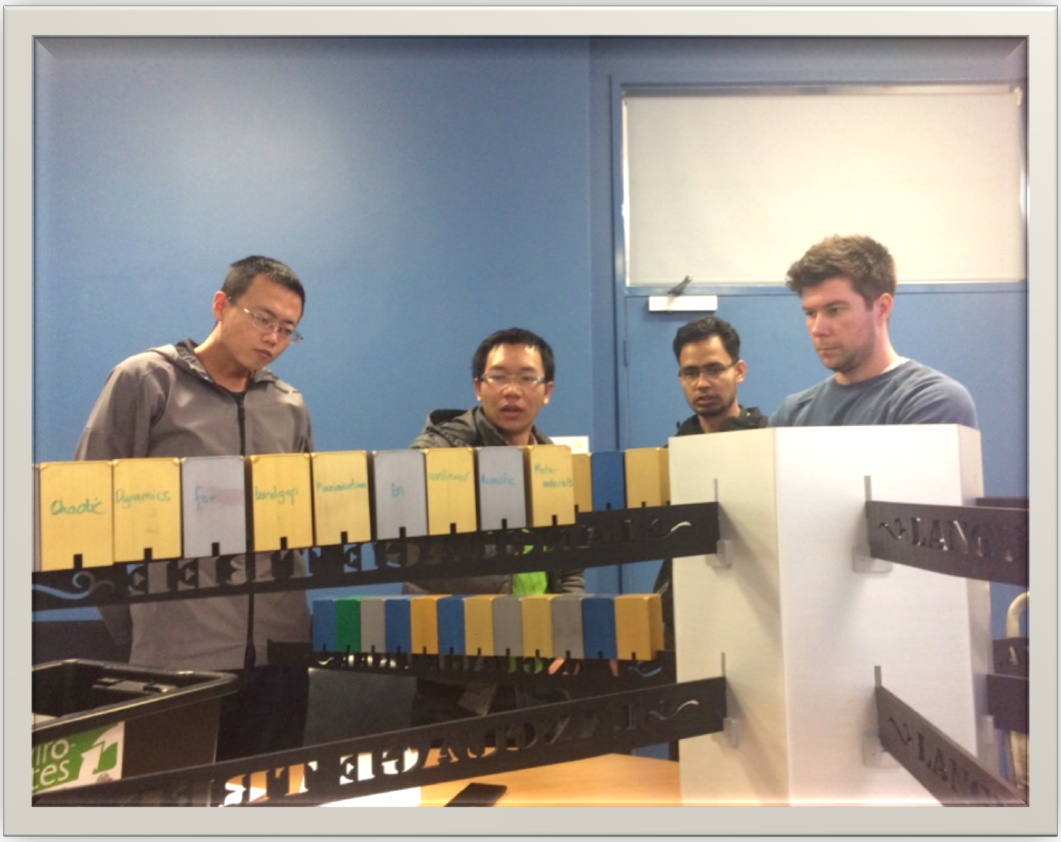


Figure 4.17: The language tree in use

Each of the three elements of the language trees (trunk, branches and leaves) must be made up each time prior, to use. This is more than a practical decision in terms of transport; this is an element of their playfulness, taking out any sting of failure and making drafting a restorative, ameliorative, non-judgmental process that can simply be wiped away with a stroke of a soft cloth. This process is important for removing the pain and self-perceived stigma of drafting, which is a major contributor to cognitive dissonance and its consequences, such as imposter syndrome. By using the familiar social form of group work, making drafting simple and offering the opportunity to simply wipe away or delete mistakes, writing becomes playful and engaging rather than emotionally fraught and daunting (Figure 4.18).

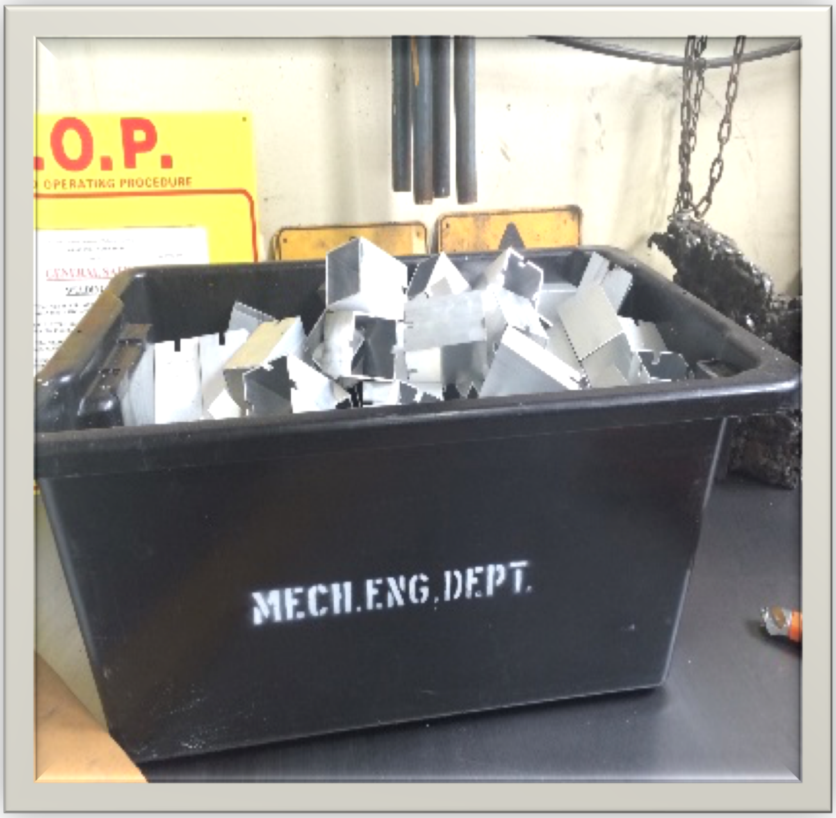


Figure 4.18: The leaves in manufacture

The final elements of the language trees are the leaves (Figure 4.18). These are essentially oblongs that are taller than they are broad. There are some one hundred and fifty available for use. The branches are in pairs on each side of the hexagon, so sentences can be written on the leaves, broken up by punctuation or extended easily in the space available.

Like the trunk, the leaves are designed to be written upon, and, at around ten centimetres high and eight centimetres across, the words can be seen quite clearly from a medium distance. There are four sides, so changes can be made simply by rotating the leaf, thereby supporting playfulness and enabling choices to be worked through. The top is also covered, so grammatical notation can be made to check for accuracy there, although the EHDRS have yet to avail themselves of this facility. The social aspect of the trees means that the students can work together on both accuracy and nuancing, supporting each other and checking for ideas.

The leaves have four colours: this was a technical proscription, based on anodising availability. This was embraced as a positive because, rather than allocating meaning to the colours, the meaning set is left open, and the students' own the decisions about colour allocation to the various possible sets of meanings. I originally saw the leaves as being more defined grammatically than they have been used for to date and they certainly can be used to support further grammatical detail.

4.2.5 Using the learning tree

Language is not just merely a system of codes and letters representing numerical-style, fixed representations of knowledge: it is a rich, nuanced, deeply social analogy of the social, cultural, experiential set of visions and representations of experience of the world (Lakoff & Johnson 1980). Deeply entrenched in powerful social and political groups, it empowers and excludes simultaneously. Participant 005 commented during the Discovery Workshops: "*I can write pages that are perfectly accurate and mean nothing: I don't even know where to find out what I do not recognise or understand. Please help me.*". The language trees are designed to assuage that desire for help by locating language in a social, physical-tactile paradigm that is non-threatening and playful, aligned with familiar ways of learning and respectful of the intelligence of the learners who will use the system. The language trees are designed to help with planning, writing and editing and thereby to answer the requests of the EHDRS in the needs analysis for help at word, phrase, sentence and genre levels.

Having established the EHDRS' own assessment of their language learning needs through the needs analysis (Table 3.2, Appendix 4) and reinforced the detail of this through the writing samples, the purpose of the Prototype Workshop was to consider the physical-tactile, visual-spatial and EMoC learning needs of the students. How these can be incorporated into an engaging language learning system that will accelerate effective academic language acquisition will be the next question. The proposed solution in this first workshop in the Prototype sequence of workshops considers the physical-tactile, visual-spatial solution, known as the language trees.

In the first part of the workshop, run on Harkness method lines, as are all the workshops, the participants reviewed the outcomes of the needs analysis (Table 3.2, Appendix 4), writing samples and theoretical frameworks for the Prototype workshops. The EHDRS agreed in a workshop discussion that the needs analysis and writing samples had been recorded, analysed and reported fairly (Tables 2.2, 3.3, 3.4, Appendix 5). This means that they are a strong foundation from which to develop the tri-partite solution and have support from the EHDRS.

The language trees are designed to stimulate attention to the language options available at all points of the writing process, from planning to finished product and remind the EHDRS of elements of self-editing skills, as well as encouraging them to use such skills either individually or as part of a team.

For this workshop (which was repeated to ensure the EHDRS' availability), early prototypes of the language trees were available, not just drawings. Several physical elements were changed or ameliorated during the course of the Prototype Workshops in response to the EHDRS' experience of working with the language trees. For example, in the first session there was no anodising of any part of the language trees and the branches were acrylic, not metal. This meant that writing on the language trees was possible, but less easy and less sophisticated in form than for the final product. The acrylic branches broke during use as engineers tend to be very strong and the material was too fragile for them. These practical changes were highly beneficial and actually helped the EHDRS to feel part of the making as well as thinking processes underlying the workshops. Their genesis from page to product proved rather long and challenging, but every individual who worked on the project had definite in-put, giving them a conceptual impact that was unexpectedly (but delightfully) egalitarian in outcome.

The learning and teaching cycle for this two hour workshop was as follows (Figure 4.19):

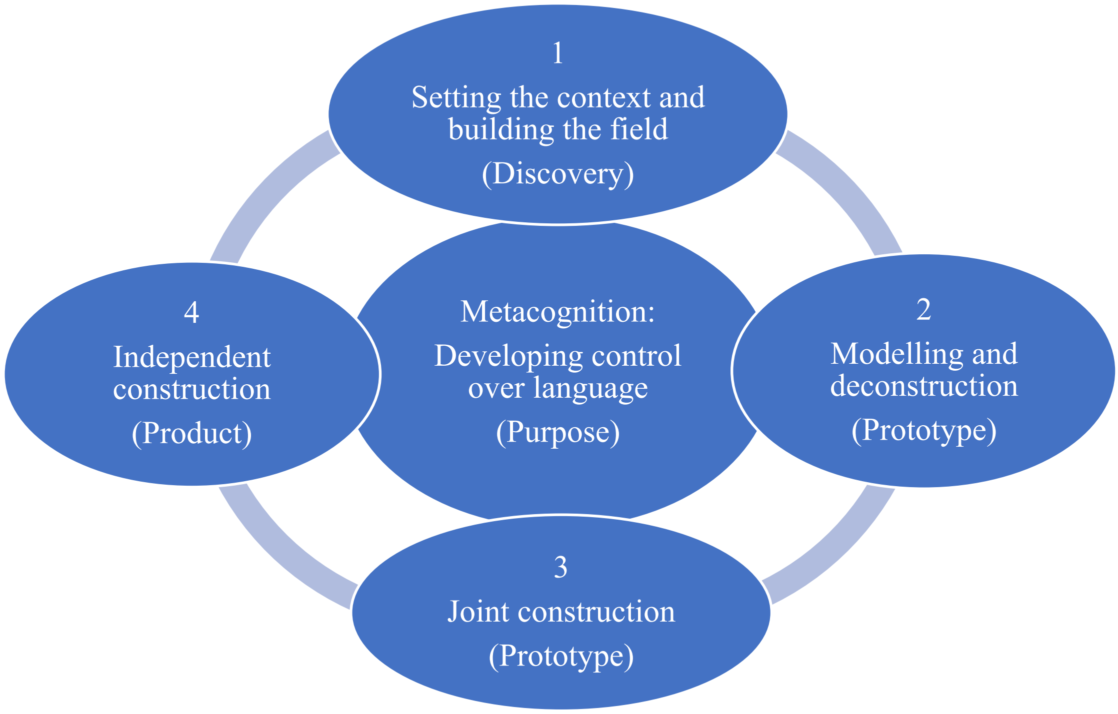


Figure 4.19: The learning & teaching cycle in Workshop 1 of the prototype phase
(Victorian Government n.d.)

The process of learning and teaching for this workshop was to start by sharing extant phrases, sentences and short paragraphs published by our own Faculty (Appendix 6) and inviting the students to play with the work to expand, contract or refocus the language. The emotional purpose of this opening task was to focus on good quality writing, establish language as flexible with multiple "correct" answers to support editing and to have fun by examining short extracts from their supervisors' published writing in order to show respect to the EHDRS and reassure them that editing is a necessary and valid process of writing development.

Once this had been undertaken, the students were invited to create or use their own sentences, titles and so forth, brought with them, and then work with first with a partner, then the whole group, to amend and polish the expression. Thus, the students moved through modelling and deconstruction, joint construction to independent construction, fluidly and organically (as per Figure 4.19).

There was a lively discussion about the origin of each example (the students became fascinated by which grammatical, syntactical and lexical markers would clue them into the writer(s)) and the quality of the writing. When they established that a senior academic was the author, it was emotionally challenging for them to work with the sentence(s), as the EHDRS are very respectful of their supervisors.

One academic visited the workshop, by arrangement, at this point, as she teaches writing skills and is both well-known to and trusted by the EHDRS. Her active support and encouragement for them to play with extant language blocks was invaluable, as it gave the EHDRS permission to see the activity as a proper academic activity, rather than criticism of a senior academic. They were particularly amused that one of the short paragraphs was actually written by her, which raised the level of engagement even higher.

The students expressed astonishment at the ease with which they could manipulate language, the playfulness of the experience and how the playfulness increased and enhanced engagement. The EHDRS' comments, gathered anonymously in the workshop, are in Table 4.1 and drawn into the formal results in Table 4.2.

Table 4.1: EHDR comments on the effects of using the language trees to examine extant writing

(N.B. These written comments were handed in without names to preserve anonymity and support the integrity and detail of the answers. The exact wording of the answers has been retained)

What is the impact of moving sentences around on the sentence itself?	**What is the impact of this movement on the audience?**
Moving the sentences around improved readability.	*This movement of sentences helps free the audience from being forced to read something tedious.*
Better grammar.	*I think my supervisor would like me to do this before I hand my drafts in. I don't know that I could manage the time well enough though.*
Removes clichés and oxymoronic phrases.	*I find this hard: there are things I have to say/keep together.*
More concise, removing redundant phrases.	*It helps with building links across sentences.*
Highlighted the fact that there is no one correct way to say something.	*The length of the sentence matters more than I thought when I work on an individual sentence rather than a whole paragraph.*
I understood any sentence can be improved.	*I didn't realise word choice was such a big deal.*
I really do like commas too much, don't I. haha	*The audience appeared more keen on removing words and moving them about. Though less keen on changes involving adding new words, unless absolutely necessary.*
I see why the passive voice is important for the first time.	*Feedback is useful.*
Broadly, it is more flexible for deciding and instituting large changes, leading to a more succinct set of sentence being created.	*It is a bit jarring to me because every sentence is very final. A good exercise though.*
It made it more succinct, however, it made it flow worse.	*It would be helpful. It helps the audience to follow the speech and not get bored. Moving parts can make a huge difference when it comes to clarity.*
It makes it more clear and easy to follow. If it is done the wrong way, it makes it complicated and difficult to understand.	*Clarity changes.* *Simplification.*
You can see what is really necessary and what is useless. More compact/focussed. Important information in the beginning and at the end.	*Learning different trains of thought from other participants.*
It limits the participants to the current sentence and it hinders the participants' ability to explore other facets of the English language.	*Makes the sentence easier to understand for someone not in the research field.*
Making the flow of the original sentence into clearer sentences.	
Can change the meaning of the sentences.	

The comments suggest that the students both understood the value of drafting for impact more clearly through using the language trees and that the physical object gave them permission to attempt this kind of drafting to a significant degree more than they had ever felt a need for before. The degree of collegiality in the joint construction phase was very powerful, supporting the contention that social learning (through joint construction in this case) is a familiar, powerful form of embedded learning for EHDRS. The EHDRS are trained to work in and value teams, so this facilitated the joint construction, even where they were not familiar with each other beforehand. It also suggests that the language trees, whilst novel, align with established EMoCS, and enable the positive movement of learning from the known to the new (Cope & Kalantsis 2008).

There was a lively discussion within the workshop about the shape of the physical-tactile, visual-spatial learning devices and the majority felt, by a show of hands, that the language trees were highly accessible. The students liked the way it is easy to move amongst the branches, and the way that changes could simply be rubbed away, leaving no trace of what they perceive to be error. Whilst one student thought a simpler, linear shape might be more stable, the group overall felt that this would be less social, and hence potentially less valuable, as only one or two EHDRS could work on such a shape at a time. The student who sought change also expressed anxiety about "*playing*" in front of their peers and "*being wrong*" with their writing, revealing the importance of affect in learning. The students did not wish to copy down the optimised sentences, as they saw this as a return to pressured writing: this was solved by photographing the branches to keep a record of the optimisations.

4.2.6 Results

As the group discussed what had been learnt through the activity, there was much consideration of where to find meaning in writing. The EHDRS understood that meaning lies at all four levels of language construction: at word, phrase, sentence and paragraph levels. The students began to see that individual lexical item choices have value overall as well as individually. There was also significant discussion about what makes a sentence specifically an engineering sentence. This is an important step forward as, for many of the EHDRS, the nuancing of language along the language continuum from very spoken to very written is an alien experience. Next, the EHDRS were asked about the usefulness and limitations of the language trees. Their discussion included the comments in Table 4.2. Again, the comments are reported verbatim.

Table 4.2: The usefulness and limitations of the language trees

(N.B. These written comments were handed in without names to preserve anonymity and support the integrity and detail of the answers. The exact wording of the answers has been retained)

In what ways are the language trees useful?	What limitations do the language trees have?
Strong visual aid	*Speed*
Focuses on the sentence structure	*We can only do one sentence at a time*
The Trees help to focus on the structure of the sentences rather than the subject of the discussion	*The leaves are so small and the words are easily erased. I personally prefer small whiteboards or black boards*
It gives a good clear way on how to restructure sentences. While it is focused on the small scale it seems to be able to change attitude regarding overall structure	*They are a bit annoying to walk around when the branches are being used*
They ensure one breaks the sentence into small chunks, due to the size of the leaves, so words aren't grouped together by accident and hence ignored	*The speed of use is limited* *In some ways paper is easier, which means most changes in my pair were done on paper first, then transferred to the Trees in my pair*
Intensifies rewording experience *More focus on detail*	*Only one sentence so hard to put in context of paragraph* *Overwhelming structure*
Reconstruct the sentence. Moving sentence around the sentences	*It takes some time to break the sentence down. Also this limits the starting point for reconstructing the sentence, depending upon how it was broken up. Perhaps some 'rules' for breaking down the sentence would be useful.*
They allow the author to focus on how the sentence is structured rather than the subject (topic) of the sentence	

The size of the language trees is an interesting conundrum: whilst large, the individual leaves are still relatively small to write on, yet engineers do tend to use a plethora of compound nouns, which require physical space for their writing. The detailed focus on words and phrases slowed down the total writing time, as it included so much editing and discussion at micro level; however, this was understood to be beneficial in terms of specific elements of the writing and to improve the whole by examining key sections in minute detail.

Overall, as per Table 4.2, there was strong approval for the language trees from within the group. This was also affirmed by the level of engaged conversation throughout the workshop and the success and extent of the optimised sentences. Participant 014's notes summed up the experience as: "*Interesting experience. Didn't expect it to be like this, but it turned out to be more useful/interesting than expected. The tactile nature of the workshop generates a playful environment in which ideas about language are able to flow freely. Good work!*" Participant 003 concluded: "*I found your method, I mean your tree, amazing. The tree makes the workshop attentive and engaging. I enjoyed it. Thank you!*"

4.2.7 Accessing meta-language

The EHDRS' familiarity with their own approaches to learning and their ability to recognise and articulate this suggested that learning the metalanguage of language itself was also fully accessible to them, with support. Whilst it was not taught explicitly in the workshops until later in Spiral 2 and more explicitly again in Spiral 3, it was used in the classroom. In part of the early conversation when task setting, for example, the facilitator (the researcher in this case) asked: "*What type of sentence do we need to match the title to the genre of the article? Is it simple, compound or complex? Is it a question or a declarative statement?*". A group discussion of the metalanguage ensued, during which the more experienced supported the less experienced with this form of language. This kind of peer learning is both social and non-threatening, supporting every aspect of the pedagogy. The playfulness of the language trees encouraged trust in the researcher and amongst the group of participants.

4.2.8 Summary and Conclusions

The playfulness of the language trees was designed to support positive learning experiences and engagement. This playfulness is designed into the industrial nature of the language trees and their physicality. With their design roots in Montessori and Cuisinaire rods, the language trees are both fresh and familiar, embodying the move from the known to the new (Cope and Kalantzis 2008).

In Figures 4.20 and 4.21, visual images of the EHDRS working with the language trees are included, revealing the students' pleasure in and focus on learning. In the first image, the student is working on her own, in an early stage of language production. In the second, a later, collaborative, stage is shown.

It was interesting that the student in Figure 4.20 chose to write on the blocks at an angle. This was entirely the student's idea. Previous students had all written straight across, but this student felt confident with the blocks and was happy to play with the physical space of the block to ensure her writing was physically clear and confident. This supports the argument that social, positive learning in a Harkness framework creates a positive affect (or emotional impact).

In Figures 4.20 and 4.21, it is worth noting that there are discarded blocks on the table, which have been written on, then edited out of the writing under consideration. This represented a physical expression of the desired editing process at work around the language trees. It is also worth noting that the EHDRS were comfortable to use the space surrounding the language trees and within the branch structure. This denoted a sense of ownership of the learning space.

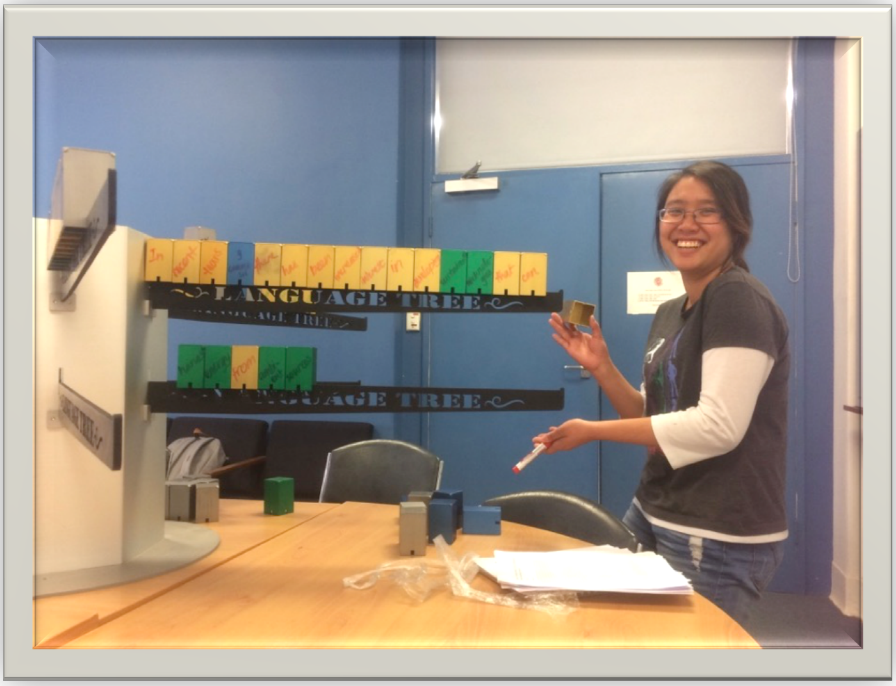


Figure 4.20: An EHDR proud of her self-editing of a journal article title

It should be observed that (other than in 4.20) the EHDRS are not considering the photographer (the researcher) as they are fully engaged in the process of editing. Thus, the facilitator has become unnecessary to the learning at this point, as ownership has been transferred successfully to the EHDRS themselves.

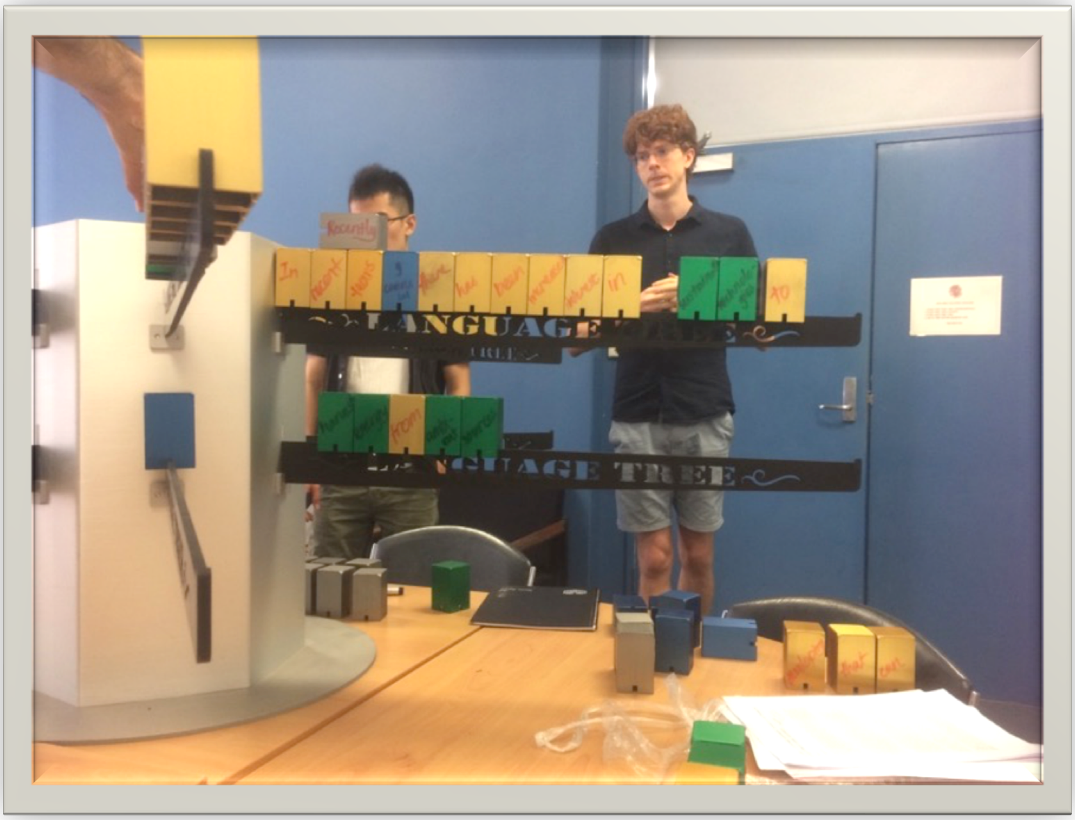


Figure 4.21: A small group supporting one another to generate journal titles

(Note the level of concentration within the group and the discarded bricks from the editing process)

We know that students move from the known to the new in their learning (Cope and Kalanztis 2008): the language trees enabled this. They used highly conceptual, visual-tactile, physical-spatial ways of learning that are familiar, coupled with a nuanced experience of language that was unfamiliar. The EHDRS used familiar technical engineering words and played with them in ways that were unfamiliar to produce new combinations and create new meanings.

The playfulness engaged the students in the task(s) emotionally and socially; providing a catalyst for learning that was essential for moving from giftedness to talent. The language trees were designed to feel industrial and engineering-friendly so that the fingers touched something familiar, whilst the brain engaged with the new language element. Above all, the errors could literally be wiped away, removing any perception of deficit as they pulled the learner forward to new success.

The level of focus and positivity should alleviate imposter syndrome, so even that the most paralysed writer can self-edit without a negative emotional impact. They should be able to do this with aesthetic beauty and academic rigour. The language trees were derived from the students' own needs analyse and writing samples, thus ownership was theirs. The pictures, and the EHDRS' written responses, also suggest that they engaged with pleasure and confidence (Figures 4.22, 4.23 and 4.24).

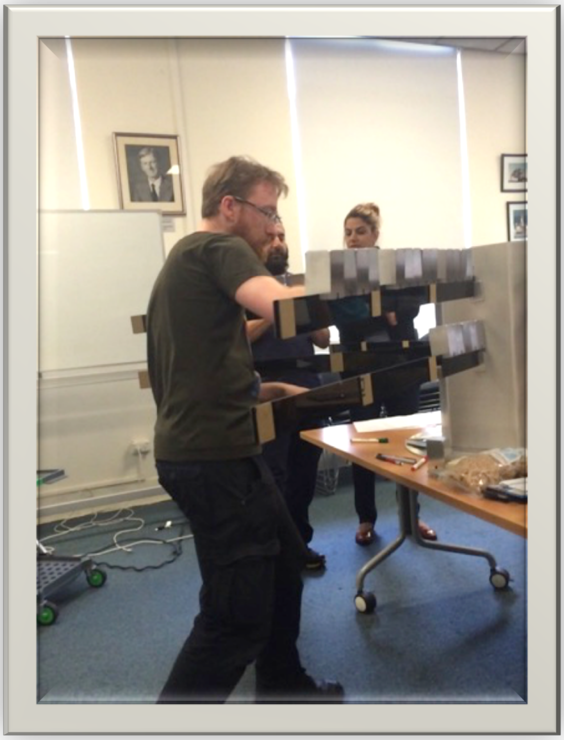


Figure 4.22: The language trees being used in group work

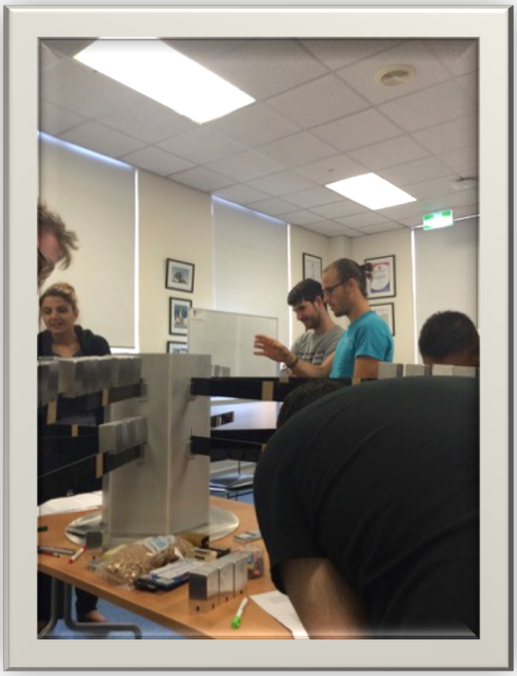


Figure 4.23: EHDRS supporting one another in their learning

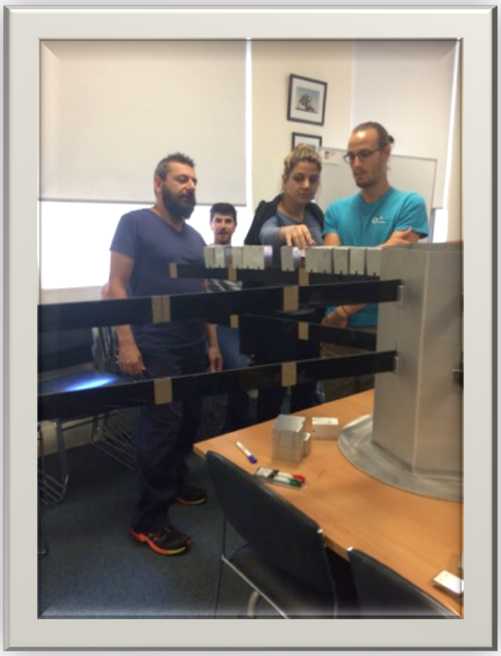


Figure 4.24: Peer editing

Using the interactive elements of the MOG TREE language trees enabled the students to assimilate their learning at genre, paragraph, sentence, phrase and word levels, without having to face a deficit model of learning and teaching. The process was fun and playful. The MOG TREE language trees engaged and focused each learner (Tables 4.1 and 4.2). It drew attention to the parts of writing in a way that was detailed but accessible and it did this within a social learning context: the students collaborated with one another and the outcome was an enhanced individual set of learnings that increased both individual and corporate capital, whilst supporting editing skills, confidence and hence well-being.

Whilst there are clearly many benefits to using the language trees, ultimately the accuracy and nuancing of the writing depends on the language skills of the group. Mistakes can still be made and may not be recognised. This is particularly true for articles (pointers "**a**" and "**the**") and collocations (words which commonly articulate with other lexical and semantic items). For this reason, the following sections describe how the construction of the Mechanical Engineering corpus can be used with a concordancing tool, in order to build accuracy, particularly with collocations (the ways in which words and phrases typically articulate with each other) or tag phrases (words and phrases which are typically used in specific positions, according to the genre being undertaken). This tool is particularly useful for bEAL/D students.

4.3 Prototype Workshop 2: Corpus Linguistics

This workshop introduced the theory and use of corpus linguistics. Corpus linguistics is included in the solution for the EAL/D and bEAL/D EHDRS in particular. It considers a corpus of writing, here engineering writing, and analyses words in use. Where English is not a student's first language (L1), access to accuracy for parts of speech such as prepositions and articles in particular, can be extremely challenging. This is also true for background speakers, and is often a hallmark of their writing style, given that their spoken language is usually perfect. The corpus can be used either by itself or within a concordancing tool.

The main issue with this workshop was attendance. With one strong EHDR voice against the proposed solution on the grounds of the time it would take, it was increasingly challenging to achieve a reasonable level of attendance. That said, those who attended were interested in the creation of a full Mechanical Engineering corpus and found the concordancing tool easy to manipulate. Those who used the corpus and concordancing tool were clear they had uses beyond those achieved by the language trees and therefore fulfilled another language need for many of the EHDRS, notably for those who are (b)EAL/D.

4.3.1 Scope

One of the issues flagged through the needs analysis (Table 3.2, Appendix 4) and the writing samples is that of accuracy with collocations and academic phrasing; both are key elements in getting journal articles accepted for publication. This is a critical issue for all postgraduate researchers, but very specifically for the EHDRS at the University of Adelaide, where the preferred form of the doctorate is by publication.

Achieving this is always challenging, but particularly so for those for whom English is not their first language, when there is enormous pressure to get work published within a tight timeframe (Cargill, O'Connor & Li 2012; Chen & Flowerdew 2018). Data-driven learning (Johns 1994) is a key way to improve researchers' language skills, which answers the need for support with collocations and genre-based phrasebanks. It also taps into the EHDRS' EMoCs as it utilises extant skills in research and data management.

Both Lee and Swales (2006) and Chen and Flowerdew (2018) observe that students can also gain from discovery learning through use of a corpus: that this process enables the EHDRS to recognise phrases they may have partially learnt in use and so extend their command of the structure or enable them to bring new uses to extant lexis (word) level learning. This skill is in addition to learning new phrasing and structure through close examination of extant published texts.

Bearing in mind that this research is wholly humanistic in impetus, considering academic writing as located and shaped by social, political and historical contexts is important (Corcoran, Gagné & McIntosh 2018). By using data-driven learning, the students are empowered in their writing and self-editing, as the corpus gives social (academic), political (within the framework of the School of Mechanical Engineering at the University of Adelaide) and historical (within the chronology of the corpus) context to new self-editing skills. From a pragmatic perspective, data-driven learning enables significant shifts in language and academic knowledge capital, without the emotional risk of an external person constantly "correcting" the work and integral world paradigm of the EHDRS' writing.

A key consideration was that the language used in the corpus must have "representativeness" (Egbert 2017 p.556). This was explained to the students by offering a diverse range of corpora, then showing how the discipline-specific corpus on offer gives far more effective and useful answers to their lexical and phrasal questions, giving greater integrity to the specific corpus under discussion. Indeed, the use of a quality concordancing tool is important when selecting responses, as the number of words either side of the word under scrutiny can be varied according to need, thereby enabling examination of not only the word but the word-in-use or "corpus-based patterns of phraseology and lexico-grammar" (Egbert 2017 P. 562). There are a number of ways of using data-driven learning, many of which were presented in the workshop.

4.3.2 Context

Use of corpora and concordancing tools has proven benefits, although the systematic use of these tools is relatively unfamiliar to many University of Adelaide academics, despite corpus linguistics as a discipline having been available for some thirty years, since the advent of electronic media. Yılmaz and Soruç (2015 p. 2629), for example, tested the differences in learning using data-driven learning against a control group and reported the following results:

> "an independent sample t – test was conducted to compare only the post test scores for the concordance and control group. The t – test analysis found a statistically significant difference in scores for the concordance group (M = 84. 50, SD = 10.659) and the control group, M = 70. 00, SD = 10; t (38) = 2.951, p = .016 (two-tailed). The magnitude of the differences in the means was very large (eta squared = 0.18)."

This suggests that the use of data-driven learning for EAL/D students in particular, can have significant beneficial outcomes.

The Mechanical Engineering corpus is a very specific tool for use in language learning by Mechanical Engineers. It comprises some 750,000 words of extant, published journal articles by University of Adelaide School of Mechanical Engineering academic staff. The articles were first collated, then turned into plain text (.txt files), with extraneous names, numbers and references all removed, so only the core articles remained.

There is discussion about the optimum number of words in a corpus in the literature (Flowerdew 1996). Whilst large corpora (1 million words +) have the benefit of access to a wide variety of instances, reinforcing their statistical significance, small corpora (+/- 250,000 words) which are sub-discipline specific, can be less overwhelming, Flowerdew (1996) argues. The Mechanical Engineering corpus contains published works by all the Mechanical Engineering academics at its date of construction, so it covers all the key research areas in our School: notably but not exclusively, Sports Engineering, Wave Energy Technology, Solar Energy and Combustion (University of Adelaide, School of Mechanical Engineering 2018). Not all are relevant to each individual EHDR, however all are included to give a base corpus which the students are able to individualise further, simply by adding in preferred papers to their own copy of the main corpus. Equally, irrelevant papers can be deleted. The Mechanical Engineering corpus, therefore, should be understood as a starter tool with accompanying training for use, rather than a definitive product for each individual user.

All those articles by the University of Adelaide Mechanical Engineering academics published over the five years prior to construction of the corpus (2011-2016) were selected for this exercise in order to ensure that the texts are as relevant as possible, conceptually current and well-written to contemporary publication standards.

Lee and Swales (2006) set a pattern for teaching using data-driven learning, whereby students are introduced to an extant corpus in a concordancing tool. The teaching starts by showing a range of corpora in diverse concordancing tools, to show the importance of using a discipline-specific corpus in the most effective and convenient concordancing tool.

The most commonly used data-driven learning for engineers at the time when the workshops were designed and undertaken, was Springer Exemplar (2017). This internet tool offered a corpus created from the Springer Engineering family of journals. Unfortunately, the Springer Exemplar is no longer in existence (Schreiner 2018), so the Mechanical Engineering corpus is now particularly necessary in the absence of any kind of appropriate commercial version.

4.3.3 Method and Discussion

4.3.3.1. **Use as a concordancing tool**

As an online tool, the concordancer can be used either as an individual, private tool, or as part of social learning (Figure 4.25).

Figure 4.25: Using the corpus in a social learning situation

In the workshop, the EHDRS were shown the process of placing the corpus into the concordancing tool, and the group worked through some examples of its use together, just as had been done for the corpus alone. To create this, the files from the Mechanical Engineering corpus should be dropped into a concordancing tool. In this case we used AntConc (Anthony 2018). To do this on a Mac (the system is also Windows compatible), it is necessary to download the web files (Anthony 2018) from the internet. AntConc is available for Windows, Mac and Linux and constantly updated. The concordancing tool searches the corpus to locate statistical evidence of language-in-use, which is clearly helpful, particularly for EAL/D and bEAL/D research students.

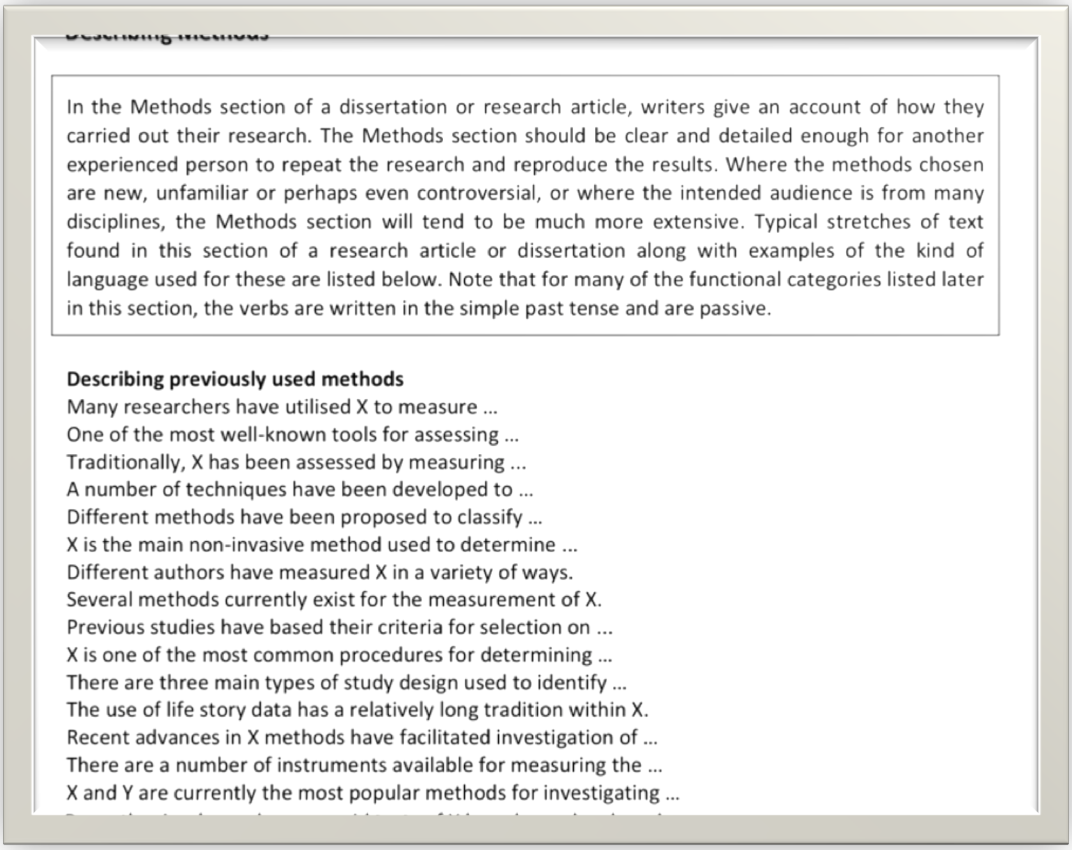
4.3.3.2. **Use as an academic phrasebank**

In addition to being placed in a concordancing tool, the corpus can also be used as a form of academic phrasebank (Figure 4.26).

Figure 4.26: Using the corpus as an academic phrasebank

The teaching pattern (Lee & Swales 2006) is to show a corpus in the first instance and to explain its use as a form of academic phrasebank. There are generalist phrasebanks in existence, notably the Manchester Academic Phrasebank (Morley n.d.), which are extremely reputable and widely used, though not necessarily within the School of Mechanical Engineering at the University of Adelaide.

The Academic Phrasebank (Morley n.d.) contains the different elements of academic writing, sorted by genre but not by discipline. The phrases are often dependent clauses taken from complex sentences, thereby setting the tone and creating a hierarchical condition for an explanation, or the theme of a complex sentence, setting up a proposition. The words used are general, open and meaningless without the interpolation of specific, new examples and ideas. Figure 4.27 is a sample of the Manchester Academic Phrasebank on Methods Sections:



In the Methods section of a dissertation or research article, writers give an account of how they carried out their research. The Methods section should be clear and detailed enough for another experienced person to repeat the research and reproduce the results. Where the methods chosen are new, unfamiliar or perhaps even controversial, or where the intended audience is from many disciplines, the Methods section will tend to be much more extensive. Typical stretches of text found in this section of a research article or dissertation along with examples of the kind of language used for these are listed below. Note that for many of the functional categories listed later in this section, the verbs are written in the simple past tense and are passive.

Describing previously used methods

Many researchers have utilised X to measure ...
One of the most well-known tools for assessing ...
Traditionally, X has been assessed by measuring ...
A number of techniques have been developed to ...
Different methods have been proposed to classify ...
X is the main non-invasive method used to determine ...
Different authors have measured X in a variety of ways.
Several methods currently exist for the measurement of X.
Previous studies have based their criteria for selection on ...
X is one of the most common procedures for determining ...
There are three main types of study design used to identify ...
The use of life story data has a relatively long tradition within X.
Recent advances in X methods have facilitated investigation of ...
There are a number of instruments available for measuring the ...
X and Y are currently the most popular methods for investigating ...

Figure 4.27: Sample of the Academic Phrasebank on Methods Sections (Morley n.d.)

The phrasebank avoids charges of plagiarism precisely because the phrases identified for each section are formulaic and non-discipline specific: these words act as commonly accepted frameworks to meaning, rather than carrying inherent meaning. In this sense they are a form of placeholder, rather than meaning-transmitter per se. There are three major kinds of plagiarism: plagiarism of words, plagiarism of ideas and plagiarism by patchwriting, where words and/or phrases are recycled with some alteration (Childers and Bruton 2015). These forms of plagiarism must obviously be avoided at all costs to retain academic integrity, but they are in widespread use amongst EAL/D writers (Pecorari 2015). The phrases in an academic phrasebank repeat endlessly across disciplines and therefore count as conventions rather than patchworking: they vivify only when detail is infused to generate meaning when they are set in motion in an original article. Therefore, use of an academic phrasebank retains the integrity of the writer and avoids accusations of plagiarism.

The EHDRS could see value in the academic phrasebank, though a powerful negative is its very openness and non disciplinarity. An interesting teaching moment in the workshop was when the students were shown how the Mechanical Engineering corpus itself can be used as a form of phrasebank. Once the students were aware of the type of phrases they could access, they opened up the corpus and considered how these work in the various positions required by nuanced, academic, discipline-specific writing. Thus, when teaching sentence diversity (simple, compound and complex sentences), it is helpful to look at how these sentence types affect and effect meaning. In the same way that the interlocution of titles includes "*Is it a question?", "Is it a statement?", "Does it need a colon to balance the parts of the title?*", so too, "*Should we start a paragraph with a dependent clause in order to evoke a hierarchy of ideas from the outset?", "Should we use compound sentences, which naturally contain theme and rheme, for development within paragraphs?", "To what extent do compound and simple sentences change conclusions?*" and within that, "*What would be the effect of a rhetorical triplet?*" can be asked. Patterns of usage offer clues to answer these questions and so the corpus has a value that is intrinsic and widespread.

4.3.3.3. **Using the corpus to examine elements of genre**

By extension, the corpus can also be used to measure and check the elements of genre. Scanning the first few papers in the corpus shows that there are genre conventions concerning the field of language use, the tenor and the volume of words selected. There are also conventions across the order of information given (Cargill & O'Connor 2013), which are recognisable patterns that can then be replicated in terms of the order of the introduction, methodology, results, discussion, conclusion and further work. The order and inclusion of these elements can be challenging for students from diverse languages and cultures which may have different requirements and conventions, notably about the methodology section, as they may encounter potential issues such as endemic industrial espionage, not plagiarism alone, given the potential applications for new engineering knowledge.

4.3.4 The Workshop

The first part of the workshop demonstrated different types of concordancing tools and corpora, demonstrating how they work (Figure 4.28) and their high-value traits by evaluating a short battery of test cases against a series of five extant systems. The EHDRS were then taught how to use the Mechanical Engineering corpus both alone and in a concordancing tool, as well as how to manipulate the corpus. The EHDRS became clear that a Mechanical Engineering corpus, derived from their own Faculty's work, would be relevant, focused and helpful.

4.3.5 Using the corpus in the AntConc concordancing tool

In the workshop, the EHDRS were given a copy of the Mechanical Engineering corpus and were shown how to use it. The first instruction was to go to File, then File Directory and open up the plain text files. They were then invited to select the groups of files that were wanted (here, those from 2011 - 2016) and select Choose. The required files dropped into the File Directory for use. The files are automatically stored under Corpus Files, in the left hand column of the AntConc window, as can be seen in Figure 4.29.

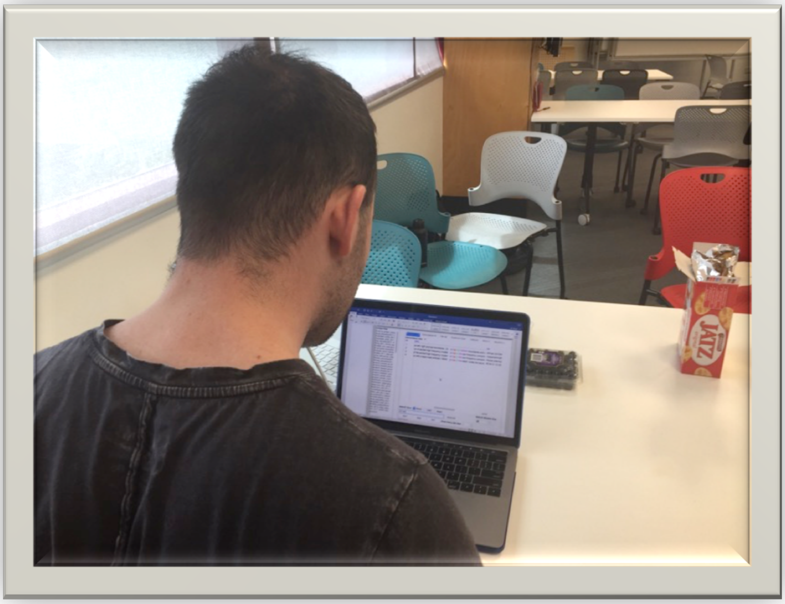


Figure 4.28: Placing the corpus into the AntConc concordancing tool

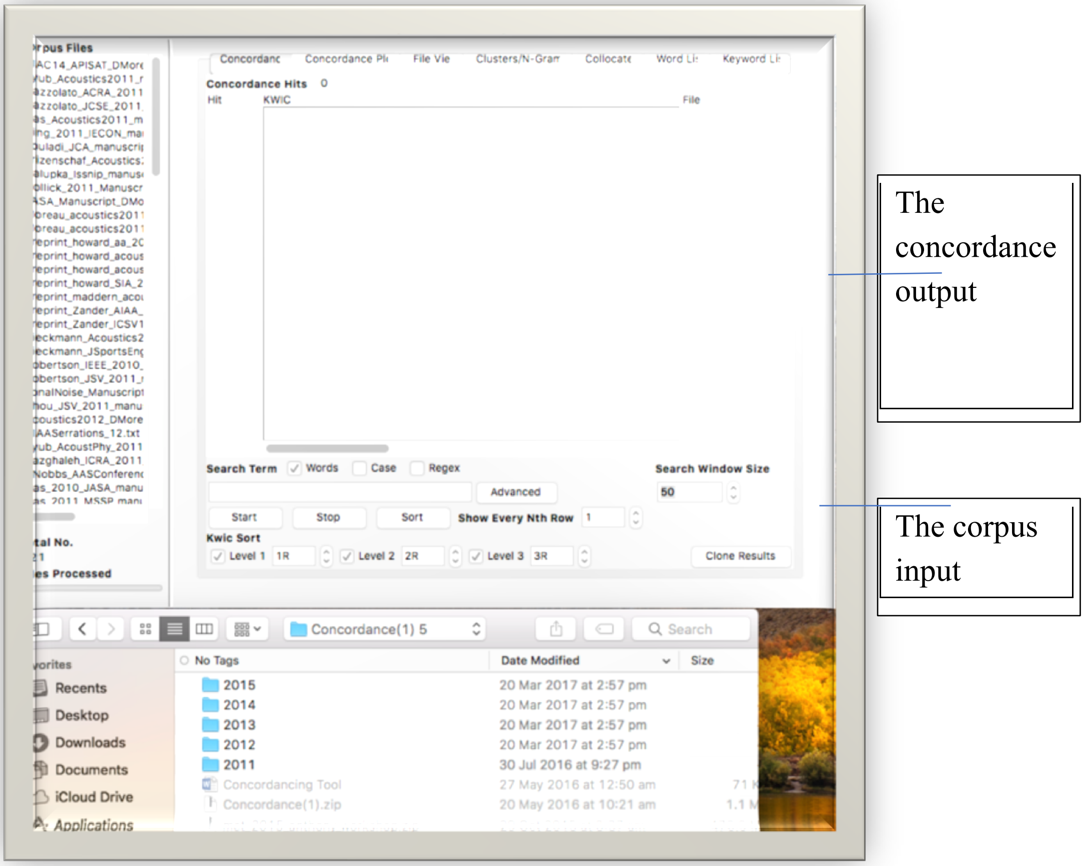


Figure 4.29: Two screens: the concordancing tool and the corpus files

There are other useful concordancing tools, such as AdTAT, the Adelaide text analysis tool (2018). AntConc (2018) was selected because not only is it very user-friendly, it is incredibly well-supported online with YouTube videos and tutorials, as well as having full real-time technical support, all of which are open access.

The negative of AntConc on a Mac system is that it is not available through the Apple Store: it is a direct download. This means that the application is more challenging to use as, without Apple accreditation, manual overrides to the security certificates have to be applied to make all the parts work on a Mac.

The purpose of the concordancing tool is to search through the corpus rapidly in order to produce lists of instances of given words, in a given frame. A simple example is when searching for a preposition that goes with the phrase "on top": the system will search for all instances of the phrase and then list all the alternatives, with statistics as to likelihood of use. Whilst the answer is most likely to be "of" (that is, "on top of") and this is an automatic answer for an L1 English language speaker, there is no obvious logic to this answer and so it is unfathomable to a non L1 English language speaker.

To achieve this basic search, the students were instructed to enter the phrase of interest in the box at the bottom of the window marked Search Term, then click Start. The results came up immediately, with colour coding to show use and frequency (Figure 4.30).

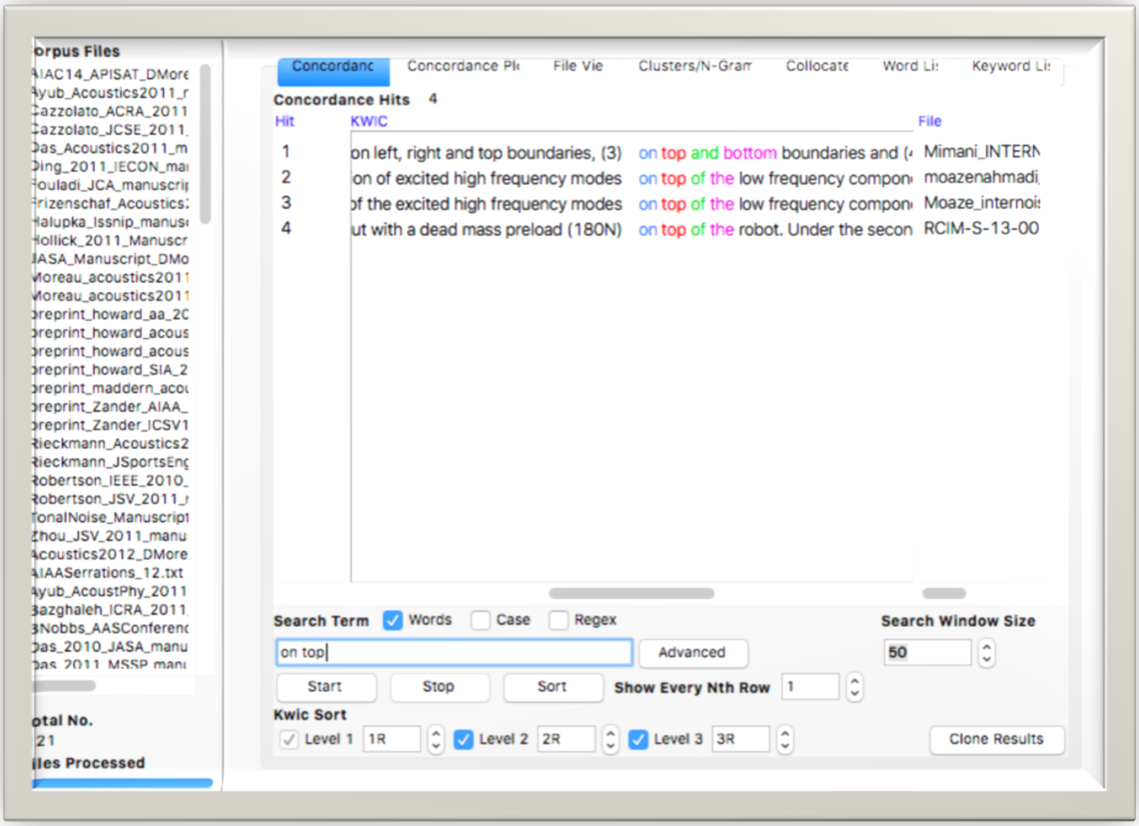


Figure 4.30: The concordancing tool in use: prepositions

The number of words on either side of the desired word or phrase can be selected and adjusted so that the word can be seen in context with a set number of words either side of the key word. In this way, collocations can be found easily and quickly, without risk of being metaphorically buried by extraneous data. The EHDRS found this very appealing.

Using a corpus to locate collocations is a critical function of a concordancing tool, as collocations are, by definition, some of the most challenging aspects of language learning for non-native speakers. They are defined by use far more than by grammar. So, whilst it is important to be able to recognise, for example, that the next word in the sequence must be a preposition, the identification of that preposition is extremely hard without being able to examine its use in context.

Beyond prepositions, probably the most critical search is for articles or pointers, which again are highly context dependent. In this case, the word "wave" was used as an example in the workshop. This word can either be a noun (e.g. a "wave" or a "Lamb wave") or an adjective (e.g. "wave energy"). Inserting the word "wave" produces many hits (Figure 4.31).

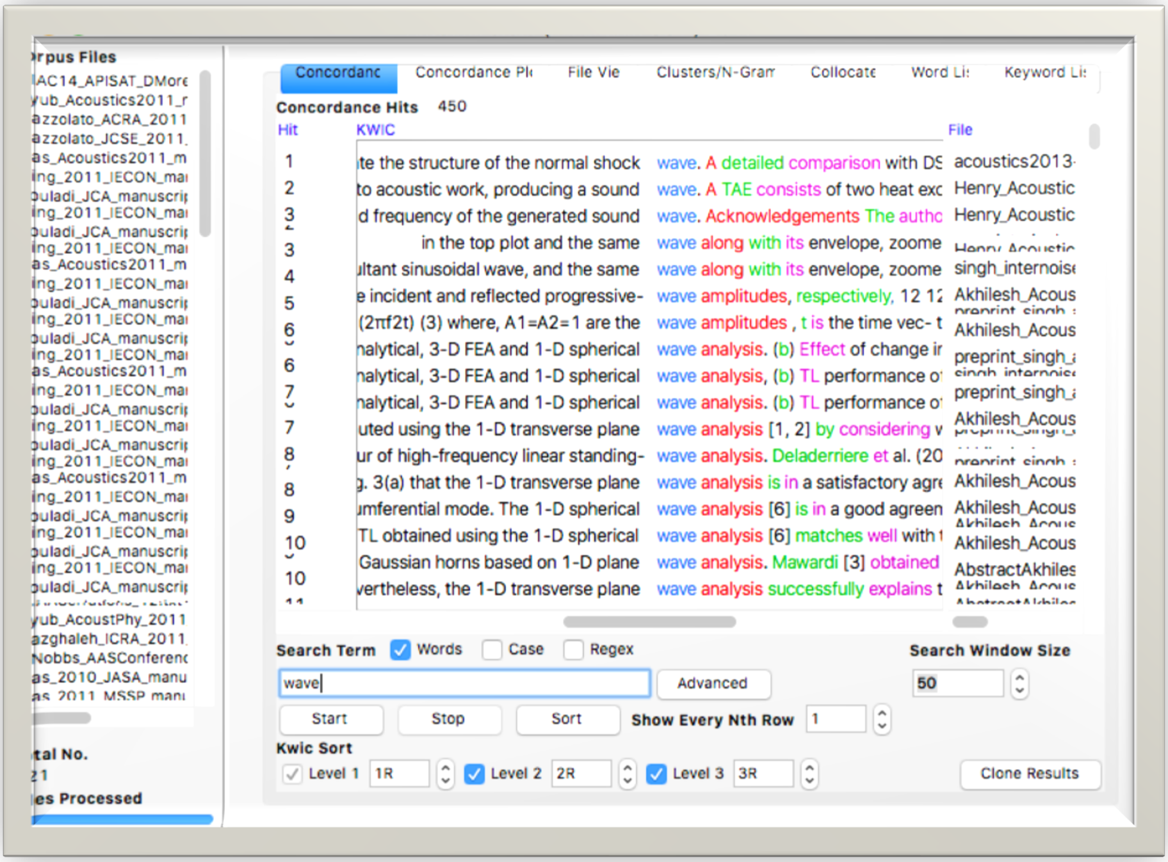


Figure 4.31: The concordancing tool in use: "wave"

This does not give a clear enough answer, so a second word needs to be put into the search engine to define the use of "wave" as either a noun or an adjective. To show the different effects of this type of search, three search types were explored. First of all, the search term ‘wave’ was entered in the noun phrase “wave energy”. Here, “wave” is the modifier, or adjective (Figure 4.32).

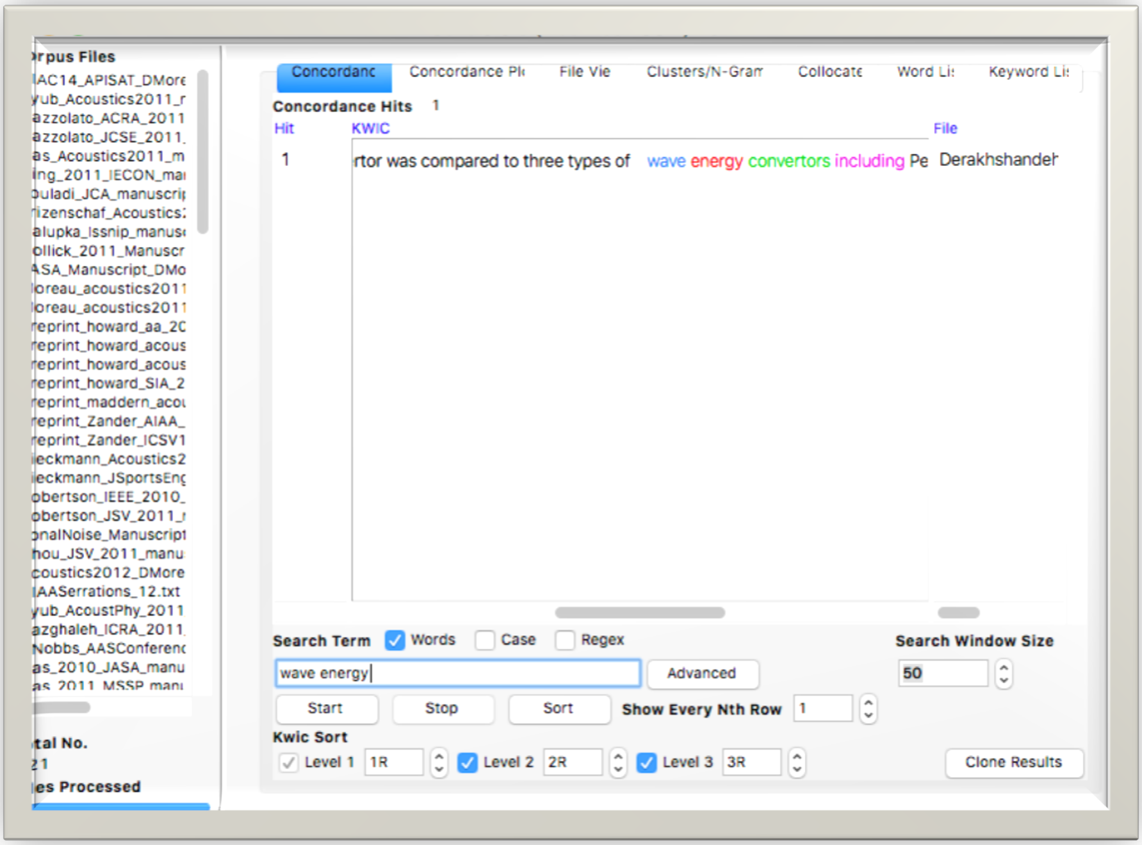


Figure 4.32: The concordancing tool in use: variations of grammatical forms

This produced one simple hit (Figure 4.32), using the plural form, which does not require either an article or a pointer.

Next the term “sound wave” was selected, where “wave” is used a noun. In this instance, it was important to look around the search term to find the articles/pointers, which are indeed used. Both versions of the article/pointer, “a” and “the” are used: frequency and context now become critical for meaning (Figure 4.33).

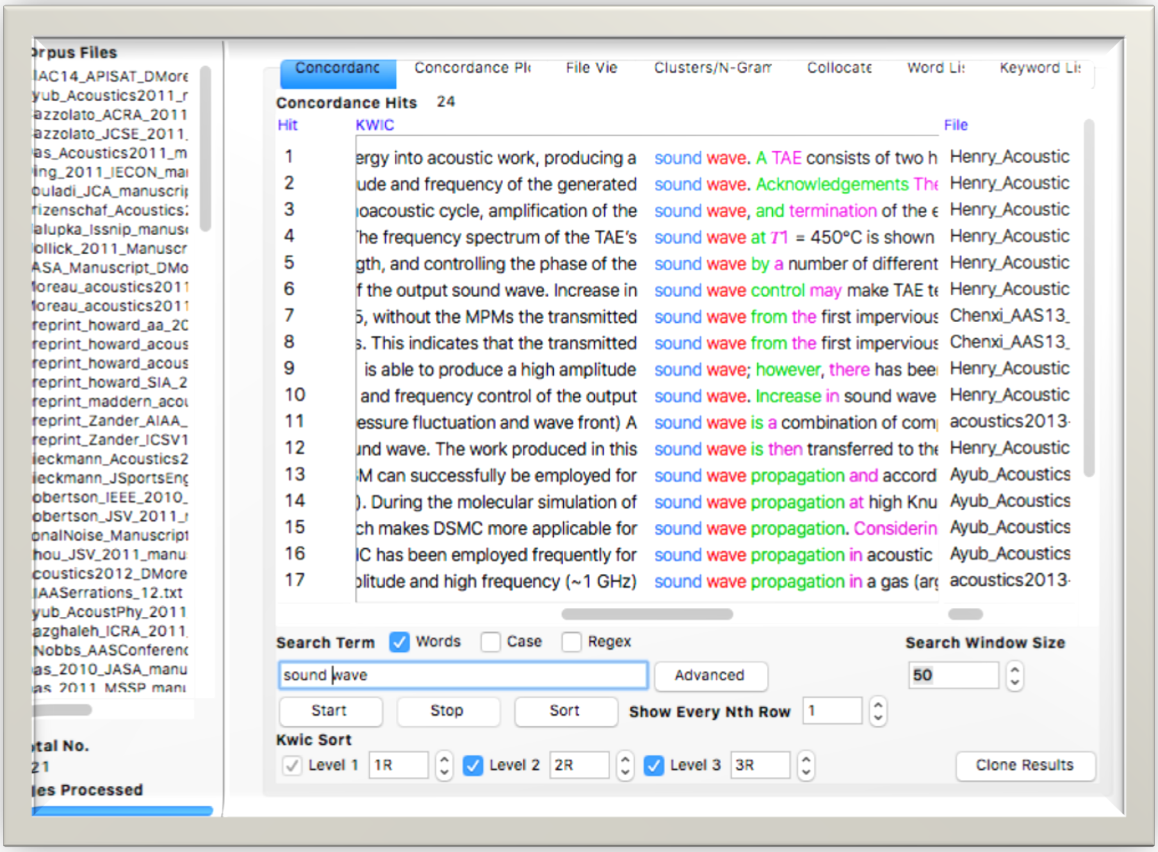


Figure 4.33: The concordancing tool in use: identification by colour

At this point, grammatical understanding is necessary, to select between the definite and indefinite article. However, the concordancing tool has established an article is needed, which was extremely helpful. The EHDRS were impressed by this facility and the demonstration won a round of applause.

In each case, the concordancing tool offered detailed, factual knowledge that went beyond that offered by a dictionary, as it offers analysis of language-in-use in specific context; that is, in academic engineering writing. In this way, the type of learning engendered is particularly valuable for EAL/D and bEAL/D students, with the authority of the volume and type of writing placed in the corpus.

In order to check these examples against dictionary suggestions, the online version of the Oxford English Dictionary (2018) was used. First, the students were invited to input the search term “on top” (Figure 4.34).

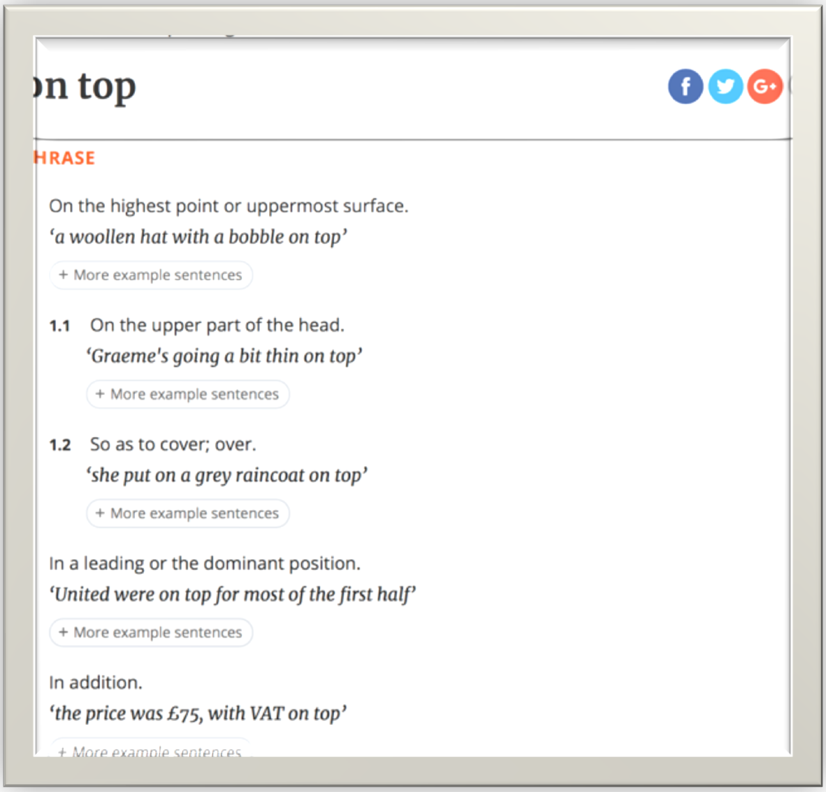
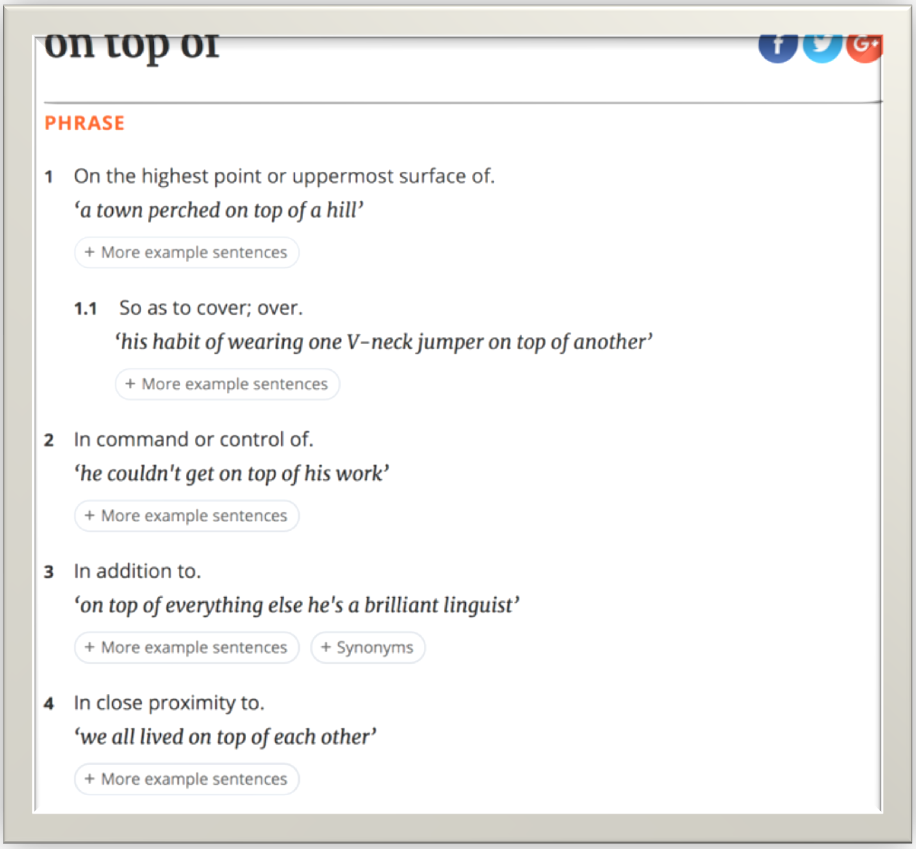


Figure 4.34: Sample from the Oxford English Dictionary, online. Note the lack of prepositions (OED 2018)

None of the examples in Figure 4.34 gave the needed collocation “*on top of*”. In order to achieve this, the whole phrase needed to be inputted, defeating the object of the exercise. The exercise was varied for Figure 4.35.



on top of

PHRASE

1 On the highest point or uppermost surface of.
'a town perched on top of a hill'
+ More example sentences

1.1 So as to cover; over.
'his habit of wearing one V-neck jumper on top of another'
+ More example sentences

2 In command or control of.
'he couldn't get on top of his work'
+ More example sentences

3 In addition to.
'on top of everything else he's a brilliant linguist'
+ More example sentences + Synonyms

4 In close proximity to.
'we all lived on top of each other'
+ More example sentences

Figure 4.35: OED Sample showing grammatical variations (OED 2018)

A second note of importance is that not one of the examples in Figure 4.35 given comes from engineering, so the critical element of language-in-use is lost. The EHDRS were both surprised and interested by this outcome, which reinforces the need for a discipline-specific corpus with a concordancing tool.

The same issues were raised with "wave". The dictionary does correctly identify the word as both a noun and a verb, depending on use, but the answers are unhelpful from an engineering point of view, even when the synonyms and extension sentences are included (Figures 4.36 and 4.37).

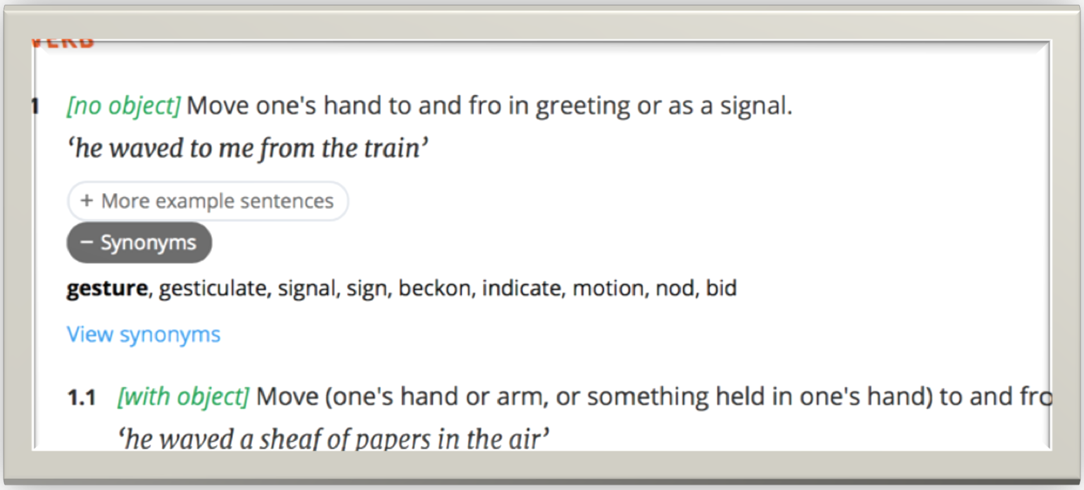


Figure 4.36: OED without synonyms (OED 2018)

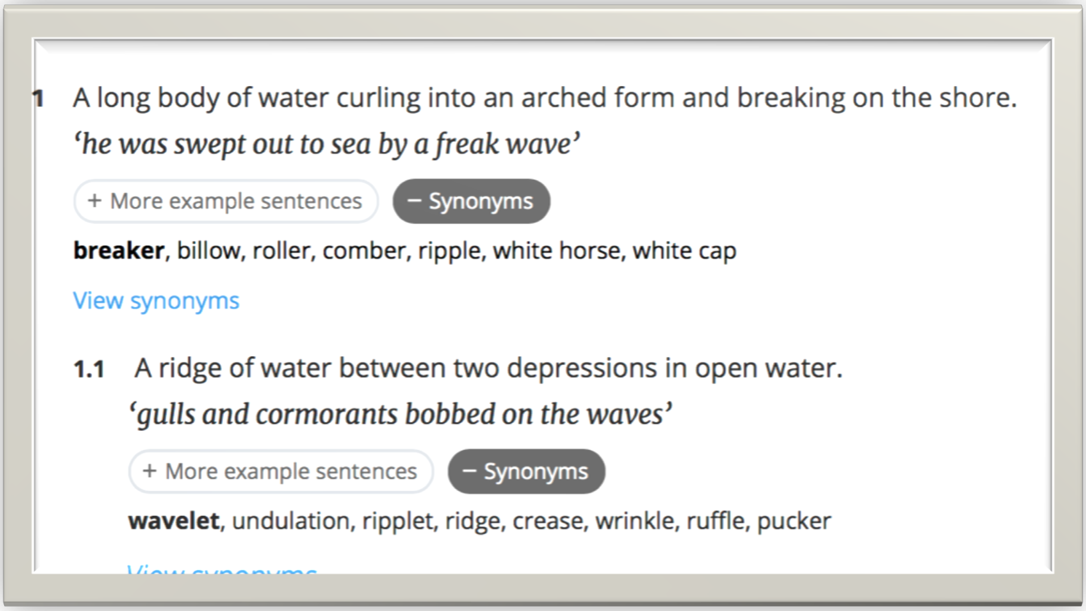


Figure 4.37: OED with synonyms (OED 2018)

Obviously, the risk with the synonyms on offer was that they did not carry an exact replica of the original meaning and therefore risked confusing the writer/reader and, indeed, misdirecting him/her.

Again, unlike a published dictionary, the corpus is not fixed: once the user has downloaded the corpus and placed it in the tool, they can add fresh, relevant examples at any stage of their writing, in order to ensure the system is fully up to date. The EHDRS were impressed by this and understood it was an important feature of a corpus.

4.3.6 Results

In this early workshop, the focus was on the use of the corpus as a searchable dataset for elisions and collocations and, as such, more suitable for bEAL/D and EAL/D EHDRS. The responses to the concordancing are shown in Table 4.3.

Table 4.3: Responses to the concordancing workshop, using AntConc and the Mechanical Engineering corpus sample

(N.B. These written comments were handed in without names to preserve anonymity and support the integrity and detail of the answers. The exact wording of the answers has been retained)

What was good about the concordancing tool so far?	What do you see as its limitations?
Very easy to install and get started.	*Dependent upon the quality of the concordance files.*
Still not sure how useful it will be in practice, but will give it a go.	*It is only as good as the files you load.*
It can help with some writing if you aren't familiar with English.	*The data library is limited.*
I can have a better idea of choosing a corpus.	

Those who attended the workshop (this had the lowest attendance of any workshop, due to prior resistence to concordancing) could see value in the corpus and concordancing tool. The EHDRS themselves raised the issue of its value over a dictionary and understood the difference through active participation in using both a dictionary and the corpus.

There is an underlying issue that the EAL/D students are not confident with meaning, a greater fear than not using a word or term correctly. The EHDRS could see positive value in the corpus but were anxious about time constraints. Whilst the data set has limitations, clearly the corpus can be ameliorated and, indeed, should be updated as new papers are published. This would speed up the search process.

The EHDRS were also shown how to use the corpus as a searchable structural dataset or phrasebank (this occurred in both the Spiral 2 and Spiral 3 workshops), enabling the students to consider phrasing in location (for example, the Methods section or the Literature Review), and this was engaging to a more diverse range of students, (Table 4.4).

Table 4.4: Using the corpus as a searchable structural dataset

(N.B. These written comments were handed in without names to preserve anonymity and support the integrity and detail of the answers. The exact wording of the answers has been retained)

To what extent can you see a use for concordancing in glossing?	**To what extent can you see a use for concordancing with preposition use?**	**To what extent can you see a use for concordancing in looking at place and head words?**	**Would the concordancing tool change how you look up words in the dictionary? Would you now look for the range of meanings on offer, check for real usage and consider collocations?**
Already use glossing, unsure would gain significantly more from using concordancing to do so.	*May be helpful.*	*Could be useful. Unsure.*	*Dictionary would still be first point of reference. Probably wouldn't be using words which I wasn't already familiar with in academic writing.*
Useful for coupling (Mechanical Eng.) is always expected to be followed by the word 'between', to indicate the relationship between two objects.	*Cross-coupling: Vortex-acoustic-coupling* *Noun+noun coupling two objects*	*In this paper* *In this case* *A systematic review of* *In this work*	*I might with some, especially technical terms where I am not sure but I think mainly I will not change the way I look up words.*
It might be helpful but I am still not really sure where to use it up to now I don't feel like I learned much from it.	*I can see the usefulness of it but has not worked too good for me yet.*	*I haven't done this yet but will give it a go, since headwords are important in setting the stage and formulating sound arguments.*	*To avoid repetitious use of conjunction words.* *To find examples fast.*
Very useful. I will use this more to compare my writing with others.	*Somewhat useful although I don't have many issues with use of prepositions.*		

Overall the response was relatively positive to this aspect of the tool in Workshop 2. Once the students were familiar with the tool, they quickly gained confidence with it, as they habitually use a range of data-driven learning tools in Engineering.

The strengths of this part of the solution really lie in the way in which the parts guide the researchers to academic language in a statistically-supported fashion, using data-driven learning, which is a familiar, private kind of learning. Data-driven learning has been demonstrated (Hadley 2002) to support learning (specifically but not exclusively) when the materials used are relevant, contemporary and the researchers are trained in their use and interpretation.

The originality lies in bringing data-driven learning into the solution, particularly for the EAL/D and bEAL/D learners. The corpus has value as a discipline-specific collection of language items and as a collection of structural guides. For the small number of students who fully engaged with the solution, the Mechanical Engineering corpus, it gave detailed support within the social context of academic writing by expert Mechanical Engineers.

Within this Prototype Workshop, a number of challenges emerged. Whilst the students were not uninterested in the idea of a corpus and concordancing tool, they felt strongly that the process took too much time. One in particular was very vocal and influential. The outcome was that almost no one attended the sessions, even when re-run for individuals to try and boost numbers and engagement.

This outcome was not replicated in the Spiral 3, Product workshop, where the students voted positively for this element of the tri-partite solution. By this point, it had been made more explicit in the teaching that this tool was inherently more useful for bEAL/D and EALD students.

The corpus and concordancing tools are particularly useful when coupled with strong grammatical knowledge and a metalanguage of grammar through which to express this knowledge capital. The EHDRS need to be able to identify sentence types and parts of speech to understand and locate pattern errors in their own work. Without this knowledge or the willingness to engage in such learning, the system is of little value and the distributed USBs containing the corpus will sit and gather dust.

4.3.7 Summary and Conclusion

This section introduces data-driven learning through corpus linguistics and its companion, concordancing. It demonstrates how the EHDRS were shown how to achieve a corpus and how to use such a corpus both on its own and in conjunction with a concordancing tool such as AntConc.

The tools in this chapter relate strongly to the EAL/D and bEAL/D engineers' needs and offer both privacy and support. With practice and familiarity, they can help the engineers increase their accuracy significantly, write appropriately and gain confidence.

Although the EHDRS were capable of understanding and manipulating this collocation tool, strong knowledge capital of grammar is essential to enable the EHDRS to know precisely what to look up and how to use what they find. This is therefore the subject of the next sections, the final part of the tri-partite language solution that is the MOG TREE system: the grammar tool, http://www.mogtreeapp.com .

4.4 Prototype Workshop 3: The MOG Tree Website

4.4.1 Introduction

Here, an outline is offered of the design and testing of the MOG TREE website, which embodies the synergetic systems engineering tool, and the elements of its creation both at a visual and a contents level. The focus in terms of content is the use of both systemic functional linguistics and traditional grammar, taking a settlement position in terms of the metalanguage and conceptualisation of grammar itself. This part of the MOG TREE system derives from the grammatical support elements missing from the language trees and Mechanical Engineering corpus, as well as from the needs analysis and writing samples (Tables 2.2, 3.3, 3.4, Appendix 5).

Language needs to be engineered correctly if meaning-making is to be fluent and nuanced. Whilst many engineers would like it to be precise and mathematical in its nature, that is not the case when learning English as language creation is an organic process. Thus, the tri-partite solution works with language in different ways, with each part being more appropriate for different aspects of the writing. The workshops that accompany the MOG TREE solution are designed to clarify which part(s) work(s) well for which problems: to tailor the solution to the problem and the individual learner.

This particular element of the solution, the website, deals with grammar and the construction of meaning from a more linguistically technical perspective. It works for those who are seeking accuracy and order in their writing, including sophisticated use of punctuation for effect. It unfolds, and so is designed to answer questions at the point of need, as well as being a comprehensive text book/locus of answers.

A key issue is that the EAL/D or bEAL/D student, in particular, may well not know where the grammatical problem lies within the sentence, so, ideally, supervisors will have a role in pointing out the nature of the error. However, by using the metalanguage of grammar, once the initial prompting has taken place, the student should then be able to work through the website, so that they can solve language issues with ever-increasing levels of complexity. This will save supervisors who engage in this process significant time and build skills and confidence in the student, rather than establishing an adversarial relationship based on panic and fear of rejection of engineering work on language grounds.

This process should also save time for both the supervisors and the students over the period of study, as everyone becomes more familiar with the types of issues raised and the locations of the solutions. However, even if the supervisor chooses not to reference grammar specifically, the student is able to do so, and thereby build up their knowledge capital. Of course, volition is important here, as Hwang (2005) observes, transnational students can face significant issues with accepting that English writing is a particular concern. By involving the EHDRS from the start of the project, some of this feeling of alienation from language learning should be abated.

The MOG TREE system is probably the most useful for EAL/D and bEAL/D students, even though they do not have identical issues with English. Their particular issues are determined by the nature of their own first language, their history of engagement with this L2 (+) language and their social/contextual engagement with language. In this way, the MOG TREE system is designed to optimise academic language learning alongside the engineering learning: a positive learning loop which is itself aligned with the design of the website and familiar engineering modes of cognition, meeting the needs identified by the students themselves through the needs analysis (Table 3.2, Appendix 4).

The data from the needs analysis (Table 3.2, Appendix 4), the writing samples and the workshops to date, all show a need for a tool offering structured, formal grammar support for EHDRS, so attention was turned to this issue.

There are currently a number of ways to access such support, notably the online tool, *Grammarly* (Grammarly.com 2017), and text books such as *A New Grammar Companion* (Derewianka 2011), *English Grammar in Use* (Murphy 2004) and their ilk. However, there are two key issues with these approaches: first, neither type of solution is written for EHDRS, so the language and focus are not designed specifically for this very defined audience. Second, neither is an easily accessible self-teaching and learning tool, so although *Grammarly* can be used to fix problems, the underlying lack of knowledge capital is not addressed appropriately for EHDRS, who use specialised language terms (technical language) and forms (the idiologue of the engineering researcher).

Unlike *Grammarly*, which offers corrections without detailed explanations, Derewianka (2011) explains grammar in enormous detail: far more than is needed for the purpose at hand, and so is liable to be rejected by EHDRS, who are looking for a short, targeted, clear answer to a specific question. This links to the needs analysis (Table 3.2, Appendix 4), where Participant 009 commented: "*Teach us what we need to know, not all that you know, when we need to know it*".

Thus, the tool to be developed needed to cover a diverse range of often conflicting issues, in alignment with the EMoCs with a searchable framework that can enable knowledge capital to be built with relevancy, in a succinct and accessible format that can be accessed at the point of need. The searchability, at a conceptual level, derives from the synergetic systems engineering approach taken, which underpinned the development of the unfolding nature of the website, its circularity and its friendly, adult tone of voice, which is respectful of its target cohort throughout.

4.4.2 Using a synergetic systems engineering approach

A synergetic systems engineering approach can be defined as one with a feedback loop, such that the information is elicited, negotiated and documented into a tool which is designed for specific stakeholders, in partnership with them (Pohl 2010). In this way, a synergetic systems engineering approach can be said to enable concepts to move from theoretical engineering to the shop floor: similarly, the MOG TREE website is designed to transition language study, notably grammar, from the theoretical world of the linguist to the practical milieu of the EHDR working on writing a thesis or article for publication.

In order to achieve knowledge capital of the metalanguage of language, the parameters of the tool must be set carefully and then stakeholder feedback must be sought in order to ensure that the website is as useful as possible. The full range of feedback refers across Spirals 1 and 2 (the Discovery and Prototype workshops), which were fully consultative, and Spiral 3 (the Product workshop), where feedback was sought on what had already been developed and pre-tested by the EHDRS.

The approach uses fuzzy logic to enable a flexible response to a finite set of questions. Fuzzy logic (Jantzen 1998) is a vibrant approach that articulates strongly with synergetic systems engineering thinking because it enables an unfolding of information: entries are not either included or excluded but can be connected and deepened through the unfolding process (via scrolling and use of hyperlinks). As such, it uses inference. This is most clearly found in the index, which enables the searchability and more/back buttons, which then enable the unfolding of deepening layers of information at the point of need. It is this condition of circularity, searchability and possibility to unfold succinct datasets that makes the use of a website so appropriate for the grammar tool and reveals the originality of the conceptualisation of the website itself.

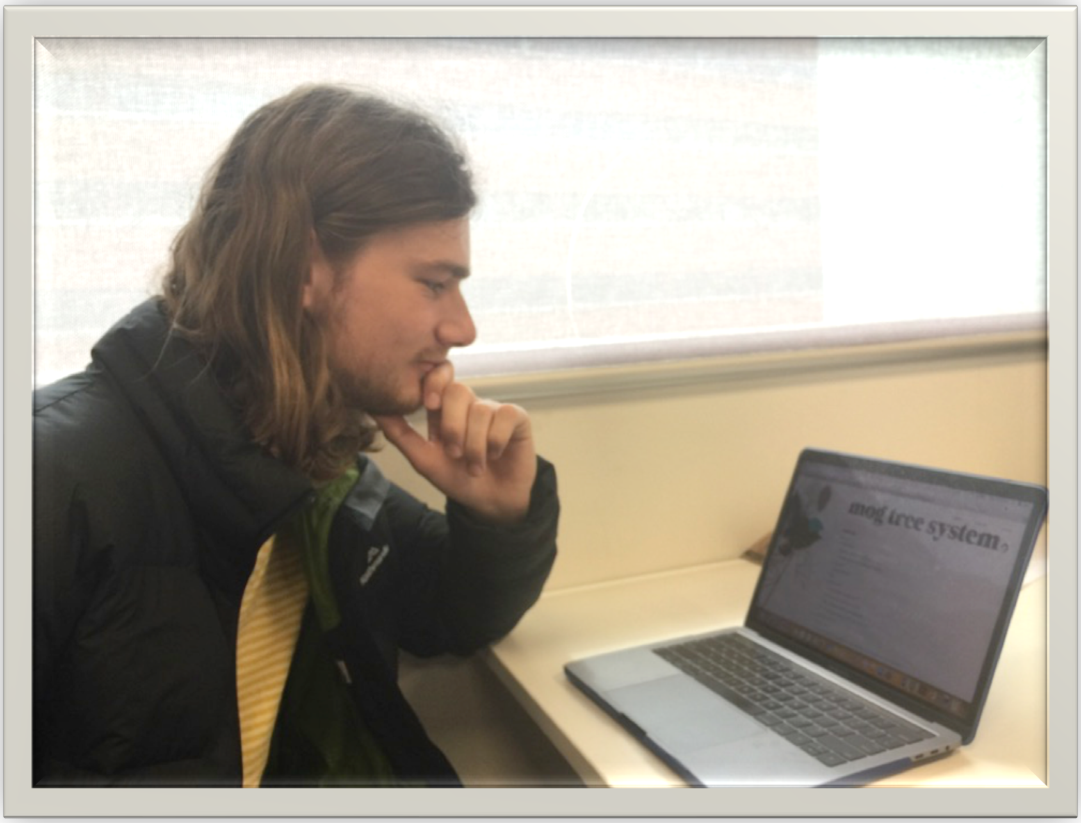


Figure 4.38: Evaluating the http://www.mogtreeapp.com website

4.4.3 Defining the term grammar for this website

Following the findings of the needs analysis (Table 3.2, Appendix 4) and the discussions that comprise Spirals 1 and 2, the concept of grammar, as used in common parlance by EHDRS (and their supervisors who periodically complain about their students' incomplete mastery of it), also encompasses sub/related issues such as structure and punctuation (more usually classified by linguists as syntax). As such, a more targeted, nuanced solution which fits with this broad definition of grammar is clearly needed for it to be used as a tool of choice for EHDRS, who are time poor and outcomes driven.

There is a further underlying issue in that there are multiple forms of grammar which have different drivers and metalanguage. Of these approaches, two dominate: traditional grammar (a more proscriptive, Latinate approach often taught in Primary and Middle Schools in Australia (Australian Curriculum 2017) and the UK (UK Curriculum 2014) and systemic functional linguistics (a more descriptive approach often taught to EAL/D students). Whilst there are sub-schools of grammar that abut or articulate with these two frameworks, traditional grammar and systemic functional linguistics are the two approaches most commonly used and recognised by the EHDRS and acknowledged in national curricula in the UK and Australia. The EHDRS were usually familiar with one or the other but rarely both. As a result of this, the new, nuanced, EHDR-orientated tool was developed in order to meet their specific needs and encompass these two, conceptually opposing language learning systems, by taking a settlement position, amalgamating the most useful elements of both approaches (Pinker 2014). Thus, the language of every element of the website was carefully designed by the researcher for the EHDRS, then tested for clarity and efficacy with the EHDRS.

The participants in this workshop were initially shown a draft, paper version of the third part of the solution. The data gained were used to inform and ameliorate the website itself. A beta version of the website was shared with those who had responded to an invitation to review it and the data from this were also incorporated into the Product version of the website.

4.4.4 Background

The first part of the workshop consisted of a lesson in layers of grammar, grammatical terminology and function, and the potential use of grammar as an editing tool. The students were then offered a highly adjusted piece of writing from outside their field of expertise and asked to correct it (Appendix 7). This exercise gave the EHDRS the metalanguage they would need and understanding of why it is necessary as knowledge capital. The EHDRS agreed in discussion that the initial grammar lesson was essential for building skills and a metalanguage of grammar for discussion. After the editing process was undertaken, the following comments (Table 4.5) were offered:

Table 4.5: Post editing comments on the value of grammatical knowledge

(N.B. These written comments were handed in without names to preserve anonymity and support the integrity and detail of the answers. The exact wording of the answers has been retained)

Did knowing about grammar help you to edit the work?	**What is the impact of knowing more about grammar?**	**In what ways is knowing about grammar important for writing effectively?**	**What limitations do the language trees have in terms of helping with grammar?**	**Any other comments?**
Yes.	*You think more about what and how you write.*	*You can express yourself more clearly with less words.*	*It makes you focus on only specific sentence with limited structural possibilities.*	*I think my first language grammar is worse than my English grammar, and I not sure how much I can/will improve.*
Yes, as knowing the basic structure and when to use commas, semi-colons etc. helps to keep the flow of the writing and emphasise key ideas.	*It is clearer when to use joining words, punctuation and so on.*	*Easier to link sentences, emphasise key ideas.*	*In terms of colour, I find it difficult to make a snap decision to place words in their classification e.g. verb, adverb etc. Maybe colour 1 for initial sentence and colour 2 for changes.*	*Hard to add punctuation.*
Yes.	*It can help better communicate with readers and tell a clearer story.*	*Practice and feedback together could be an effective way in my opinion.*		*I'd like a cheat sheet for editing. I'd like examples of common errors and how to fix them.*
Yes but the paper had fairly large structural issues which I think just knowing what	*You see more errors in work and become compelled to fix them.*	*You can most effectively get your point across.*	*They can really only be used when one or two words need to be fixed. Structural*	*I feel better now reading some other work. Get the structure correct and*

they wanted to say would help fix.			*issues will be too drastic to change.*	*everything else will flow.*
Yes it does.	*It is enable me to clearly express my idea in writing.*	*I don't know.*	*Help to rearrange the words around.*	
Somewhat, there were greater issues effecting the readability of the piece.	*It improves one's ability to make a readable piece of work.*	*It can assist with avoiding ambiguity and ensuring the writing is cohesive and easily read.*	*They do assist with considering the placement of nouns, verbs etc in a sentence/title, but rely heavily on the users' knowledge.*	
Yes, but it is limited by how you assume your work is interpreted i.e. there are some things it won't help with.	*It improves the quality of the work produced.*	*It assists with clarity.*	*They only act as a mechanism for what people already know/are aware of.*	
Yes, it is quite helpful, but I think I do not have serious problems in the grammar area. Most of the time my sentence is grammatically right but it does not sound natural to native speakers.	*It would have very positive effect on my writing but as I said before it is not just about the grammar.*	*Knowing about grammar helps me to have more confidence while writing.*	*I cannot think of any. I found the Trees engaging and effective.*	
The text had so many problems and knowing just about the grammar was not very helpful.	*When I have a solid knowledge of grammar, I can pick up errors more confidently.*	*Whilst writing complicated sentences, I have more confidence. I can step out of my comfort zone.*	*I cannot think of any right now. I can tell you about the limitations when I play more in the future (probably!).*	

After a summary discussion of their written points, the workshop moved to a discussion about what was required in a grammar tool of some kind. Careful notes were taken throughout the discussion. The students also recorded their thoughts on paper. It was felt that an app. or website would be the most appropriate method of delivery as it is both quick and searchable: it also fits in with the efficacy and familiarity of data-driven learning. There was anxiety about the level of detail required and it was felt that this somehow had to match the level of need. It was very clear to all that the examples needed to come from the language of engineering in order to have relevancy and therefore be used. All the participants in the workshop expressed a strong desire to secure their knowledge of grammar and the idea of developing a grammar tool was warmly welcomed. There was some anxiety expressed about their (un)familiarity with the metalanguage of grammar. It was clear that there was a balance of systemic functional linguistics and traditional grammar knowledge within the group. A settlement position, acknowledging and balancing the two, would therefore be important as it would enhance access for everyone.

At this point the proposed grammar app. existed only in draft, paper form. Following from the discussions and feedback, the draft was revised and made into a website. This was then shared with a sample group of EHDRS for review before the Product Workshop.

4.4.5 Designing the grammar tool: http://www.mogtreeapp.com

Data from the Spiral One Discovery Workshops, including the needs analysis (Table 3.2, Appendix 4), writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) and the outcomes of the semi structured interviews in the earlier two Prototype Workshops, were drawn into the experimental design. The findings of these workshop discussions were evaluated for their strengths and limitations. Unmet needs were considered in detail in order to achieve the nuanced solution sought. The final evaluation of the Product is given in the data from the Product Workshop (Spiral 3): this is covered in Chapter 5.

The synergetic systems engineering tool, http://www.mogtreeapp.com (Figure 4.39), includes a welcome page to the website: the elegance of the design is important, as it encourages intuitive use of and engagement with the contents. Attached to the page, via the more button, is a short outline of all three parts of the MOGTREE solution, inviting engagement with the whole project. The language used builds knowledge capital and sets the engineering framework for the project.

Figure 4.39: The Welcome Page of the MOGTREE Website, http://www.mogtreeapp.com

4.4.6 Designing the website. Issues, parameters and solutions

Once the need for the website was established and feedback had been given, the final design and coding work was undertaken. A key intricacy of the conceptual design of the website derives from the complexity of meeting all the stakeholders' needs, in contexts which may or may not be attached to face-to-face teaching. Research into website creation was undertaken using a business model, as this incorporated content, functional and aesthetic design in terms of the user experience.

The first set of issues to consider, prior to designing the website itself, were the parameters of the website, so that the content, functional and aesthetic design (the User Interface Design (UI) or User Experience Design (UX)) of the website underpin and express both the tri-partite system and stakeholder needs. A framework from *businesstutsplus.com* (2017) was used as a thinking framework, heavily adapted to suit the research (rather than business) orientation of the website. Thus, the order of answers follows the pattern from the *businesstutsplus.com* website (2017) (with some editing to ensure focus on this specific, non-commercial site): the answers are driven by data from the needs analysis (Table 3.2, Appendix 4), writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) and workshops.

The website enables the EHDRS complete, private access to the grammar information it contains, which was designed to appeal visually to its specific audience through the use of colour palate, the imagery of highly structural trees, linking back to the language trees, layout and ease of manipulation.

As this website is research-focused at this point, there is a “Contact Us” form (Figure 4.40) for feedback on the website, contributing to the synergetic feedback loop. Such feedback is anonymised. To date, it is unused (December 2018): all feedback has been generated through the workshops.

Figure 4.40: The Contact Form

Originally, it was envisaged that the format would be an app. (hence the name *mogtreeapp.com*) but it became clear over time that constructing a multi-platform app. that would run natively was both technically challenging and functionally unnecessary. A website therefore provided the simplest mechanism for the widest distribution and the greatest ease of use. Links can also be made to the other parts of the system (for example, the recommended concordancing tool), helping it find its integrated place in the tri-partite solution.

Whilst the content developed for the Product website could, in theory, be presented on paper, to do this would cause such violence on the function and usability of the material, as to render it almost worthless.

The website is currently part of this research but it is hoped that it will continue to be useful beyond the life of the thesis: it is presented, therefore as a site in its own right, with links to the other parts of the research. All the data gathered will be monitored closely to see if it is likely to achieve one of the goals of “Future work” which is to version and commercialise it for new learning sectors.

As a non-engineer, language and literacy teacher, my background sets me apart from the other creators of the mogtreeapp.com website, who operate in the commercial world. For me, the website is focused on a highly specific educative purpose and hence a niche market. This work is not just the product of three years of close research, development and testing, but also some twenty-five years of experience in teaching language for specific, targeted audiences. The audience for this particular website is EHDRS. All the language and design work need to reflect the intelligent, adult, engineering audience, and show respect for the audience through the authenticity and elegance of the website. There is a clear gap in the Engineering Education market but also, suitably versioned, in others like it, at all levels from primary to tertiary and across all disciplines.

My current clients or target audience range in age from 21 onwards, with the bulk in the 20-35 range. There are more men than women, but that is changing with the support for women in Science, Technology, Engineering and Mathematics (STEM). They are all research students primarily, but not necessarily, in Australia and other English-speaking countries. The website therefore needs to be ungendered in design but appeal to a young adult market, without excluding those who are studying later.

The website needs to work on mobile phones, tablets and laptops, which means it must be flexible; both responsive and adaptive to screen size and resolution. The EHDRS using this website, in the test base at least, have stable internet connectivity through the university or through their own mobile data streams, facilitating access to suit their needs.

The budget for this website was extremely limited: an honorarium for the coder and lunch for the designer were all that was possible. It is hoped that any performance issues arising in testing that cannot be ironed out within the budget or the scope of this research project may be corrected in future, commercially-supported iterations.

The website took more than a year to get to a level suitable for serious beta testing, partly because for the coder and designer this was a mostly voluntary contribution, but mostly because of the detailed work involved in conceiving and developing the content, which was the work of the author alone. Although I had technical help with delivery of the website, I signed off all decisions and take full responsibility for their application.

It is essential that the design of the website articulates with the other two parts of the solution. The UI needs to be simple, clear and intuitively navigable. This is why the website is designed and coded from scratch, rather than using a template designed for a generic commercial outcome, for this specialized educational purpose. The MOG TREE name is echoed in the logo for the website (Figure 4.41), tying in with the other elements of the solution and all presentations around the research.

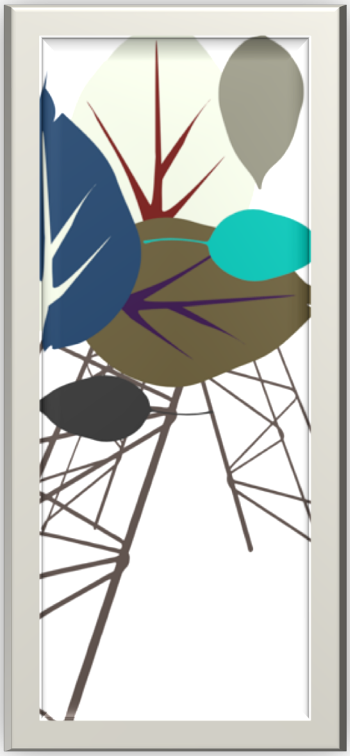


Figure 4.41: The MOG TREE logo

The apple leaves on the stylised tree in the logo (Figure 4.41) have a very strong structure and give shape to the logo, which is supported by architectural struts. They are based on stylised drawings of the apple leaves from my mother's garden. The logo is designed to sit on the lower left hand edge of the website. The branches and trunk are based on architectural trusses to suggest the delicacy of the filigree and the fragile strength of the aluminium of the language trees, along with the colours and the simplicity of the shape. The idea is to link all the elements of the tri-partite system visually, as well as conceptually.

It is critical that the solution becomes embedded in practice, in order to evaluate impact. The repetition of the logo across the elements, correspondence and research presentations is important to support the process of embedding the MOG TREE system into the learning and teaching in Engineering at the University of Adelaide. The visual element, together with consistent type elements and page structure, reinforces the brand as a professional and institutionally-supported model for learning.

There were some complexities dealing with the drivers of design, functionality and coding. The original visual design incorporated more levels of searching and page lengths, for example, however the coder felt there were dangers of feature creep, and so these elements were curtailed to maximise ease of use and simplicity of access.

Even though http://www.mogtreeapp.com is created to be one part of a tri-partite solution, one of the interesting complexities is that each part of the MOG TREE system aims to be as complete a product as possible, rather than an ugly beta product. This decision was made in order to encourage active use and responses to the system: for this reason, aesthetic design (to carry the MOG TREE brand) and ease of functionality (in order to encourage the EHDRS to want to use/handle/play with each element) are an essential part of each element of the solution.

This website was conceived as being able to entrance and capture the target audience, honouring their intelligence and time investment in the bold but sophisticated solution(s) they are exploring. It also serves to provide cohesion across the disparate items within the brand, helping it to be understood as a system, rather than a collection of tangents. In the same way, the content must be full enough to cover all likely eventualities, whilst streamlined and succinct enough to be targeted and engaging: a complex balance requiring deep empathy with and knowledge of the target audience.

The content was created and pre-tested in Prototype form, ensuring the accessibility of the language and item selections, and this and the design elements were tested in stakeholder forums before publication. All suggestions for changes were considered from the content, design and coding/user interface perspectives.

Now that http://www.mogtreeapp.com is in the public domain (Figure 4.42), all user feedback and all changes will be monitored for later adaptation of the site itself when it moves into the commercial phase, post conferral of the degree. There are no online selling facilities at this point, as the system has yet to be commercialised, however the coding is uglified (that is, made impenetrable to protect its integrity) to protect the integrity of the work.

Figure 4.42: Exploring http://www.mogtreeapp.com

4.4.7 Creating the website at word level

The first task was to evaluate what kinds of grammar/syntax should be included in the new tool. A range of published grammar guides were examined in order to find samples of what is typically covered for students (Derewianka 2011; Caplan 2012;

Riddle 2015; Barrett 2015; Sinclair 1987/2017) and then engineering writing was considered in more detail.

Alongside this review of extant texts, the writing samples (Tables 2.2, 3.3, 3.4, Appendix 5) were reviewed to look at the types of errors typically made by EHDRS. This review showed that there are levels of errors (at word, phrase, sentence and genre levels), all of which interfere with meaning-making.

The first layer of the website encompasses what is known as the parts of speech in traditional grammar (Figure 4.43), operating at word level, where knowledge of individual lexical items is critical. Acknowledging the reality that traditional grammar and systemic functional linguistics diverge at a most basic level required a settlement position, whereby the language of both could be exploited effectively. The explanations created are designed to enhance familiarity with a metalanguage of language. The eighth part of speech, interjections/exclamations, is not covered because it is not used in academic engineering writing.

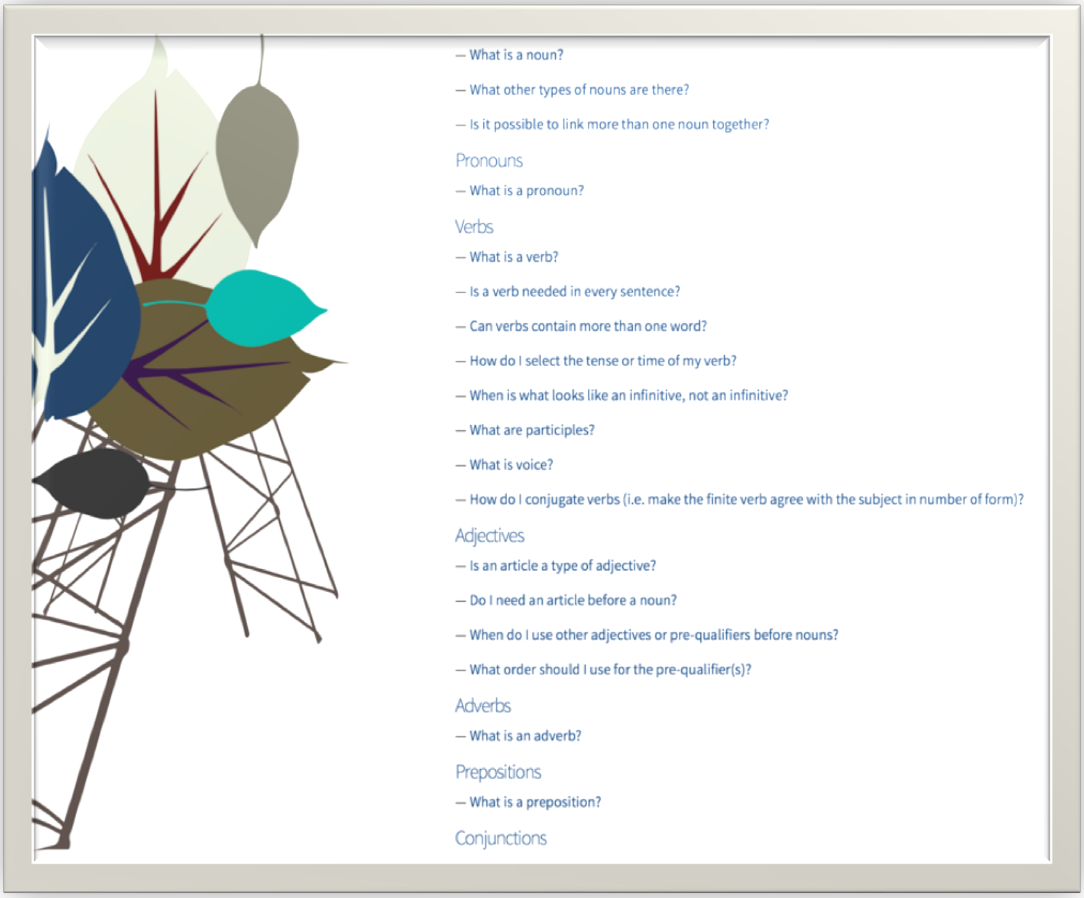


Figure 4.43: The opening page of mogtreeapp.com, showing the levels covered by the site

Opening up Word Level - Nouns, introduces the first set of options and information. As can be seen in Figure 4.44, at the start of each part of speech, there is an outline of how the part of speech articulates with the other parts of speech to move through into phrase and sentence level. This gives the context of use that bridges the traditional grammar nomenclature with the systemic functional linguistics functionality of grammar. The explanation also enhances the EHDRS' knowledge of the metalanguage of grammar, building familiarity in use or social context.

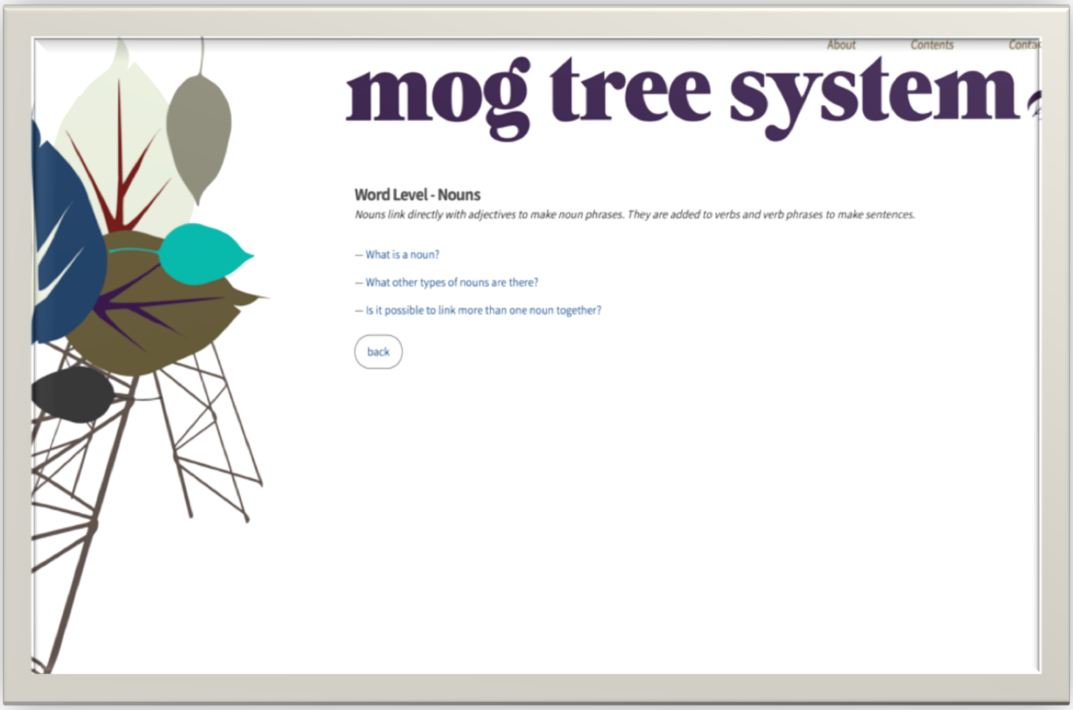


Figure 4.44: Word level – Nouns, opening page. language in context

The second decision was to use questions to index the contents. This form was chosen to increase the sense of affirmative, direct dialogue or interaction with the website, as though the voice of the EHDR comes through on the page in a friendly fashion, engaging directly with the persona of the website.

The "back" button mirrors the "more" button mentioned earlier, enabling the EHDRS to select the level of detail they wish for their answer. This gives them control over the information flow and type, as the desire for knowledge will be tempered by the urgency and nature of the writing task. Entering the pages (Figure 4.45) by selecting a question in the index, there is a secondary index through the key or headwords at the top of the page. In this example, the "more" button at the end of "*i*" has been selected to give further information. The first explanation has been greyed out to direct attention visually onto the second.

The head-words are matched within the pages and can be clicked to link ideas. This reinforces learning of the metalanguage of grammar and increases the circularity of the website as the words link across the levels of grammar, taking the EHDRS into options at phrase, sentence and genre level from word level. The purpose of this is to support the inter-connectedness of the approach and enable the students to find their individual pathway through the explanations, at the point of need of the knowledge. If further explanations are not required at any given moment, the EHDR can return to the welcome page. Thus, the website is able to match the EHDRS' requirements and individualise the functionality of the website. The language used for the explanation has been refined in an attempt at maximising clarity in conjunction with the EHDRS. The tone of the website speaks directly to the reader (you, or the implied, vocative, you: 2nd person singular or corporate (i.e. all EHDRS)) to enhance engagement and gives the simplest explanation possible, whilst acknowledging the intelligence of the reader and speaking to them as an engaged, educated adult. In this sense it mimics the overtly social nature of the language trees, to which it connects directly. This is also part of reinforcing that the website is necessary and emotionally neutral: that is, it should dissipate rather than exacerbate imposter syndrome.

The website format avoids a major issue with text books: confusing multiple page references. Figure 4.45 shows that the hyper-links can be used to take the user through the individual pathway they require at any given instant, rather than through multiple pre-set pathways, many of which could be redundant, confusing (or at least irrelevant), for the user at any particular time. It also makes the information easier to read on the screen by limiting the volume of information for each search, and it clarifies distinctions of level by making them visually distinguishable. As soon as the lexical item is placed into the context of word-in-use, it has to be understood at phrase and sentence level in order to have accurate, nuanced meaning.

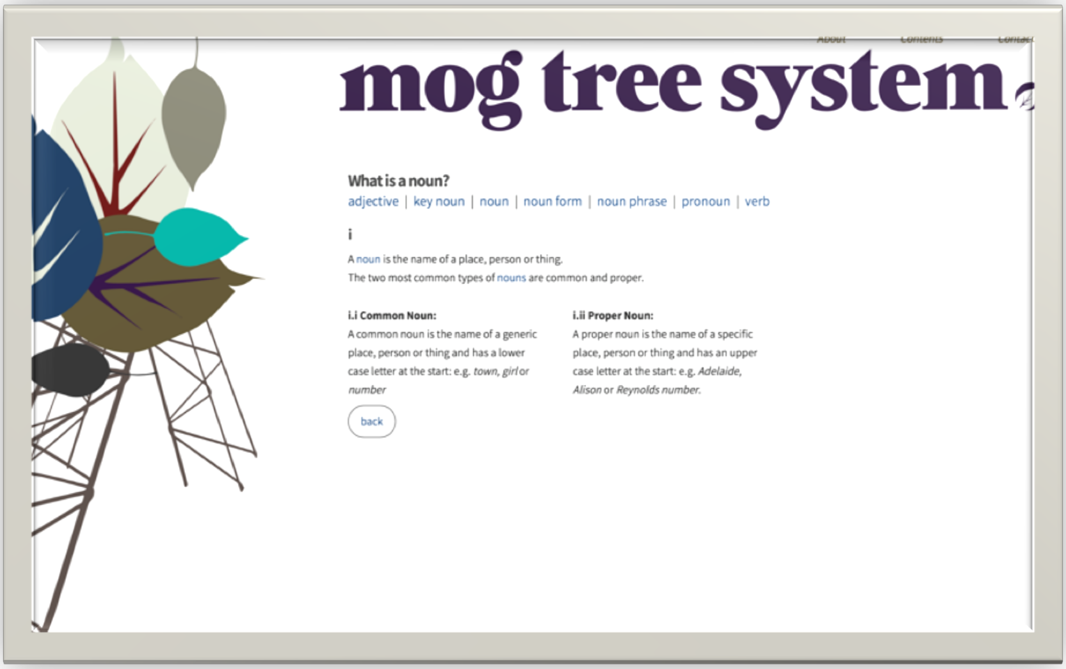


Figure 4.45: Unfolding language at word level

Figure 4.46 also has elements such as capitalisation, which connote meaning-in-context. As the metalanguage unfolds, so too does the syntax and level of complication or nuancing. By locking explanations onto use and the detail of collocation, syntax and punctuation, language is unfolded in meaning and construction, making the explanation functional as much as descriptive, thereby lying at the crux of meaning-making.

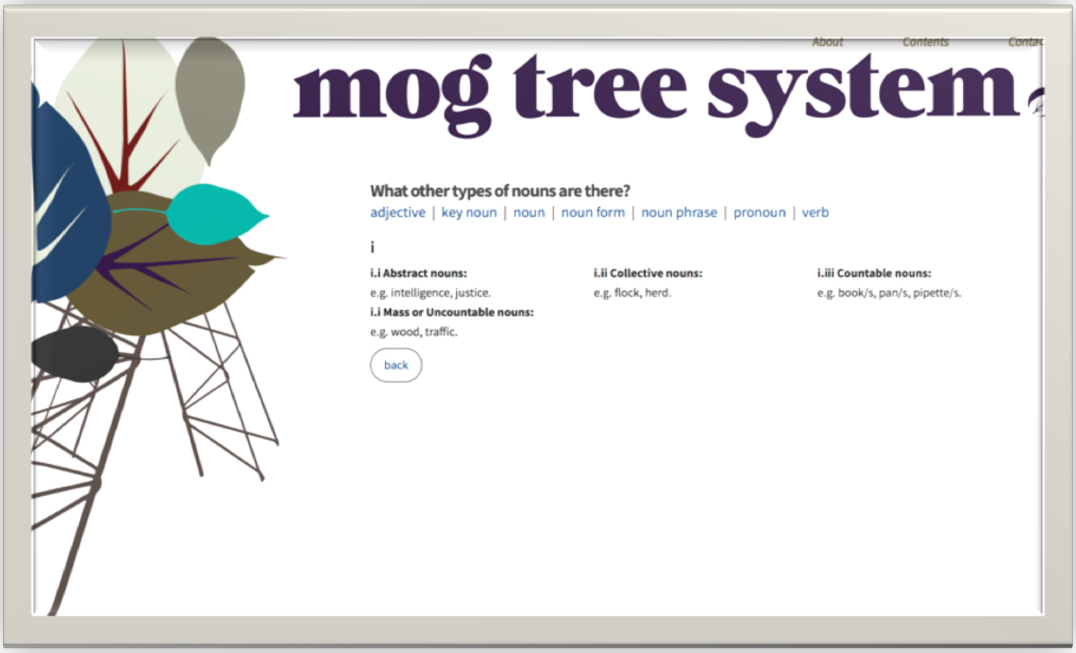


Figure 4.46: Unfolding language ready for collocations (here, articles or pointers/pre-qualifiers)

By the third question and final response (shown in Figure 4.47), the links to punctuation also come into play in terms of enhanced meaning. This moves punctuation away from primary school-child perception of punctuation as an indicator of breathing and into the adult, technically accurate realm of punctuation as a functional form of social meaning-making for effect.

The headword and internal links enable the viewer to recheck adjectives, for example and, again, unfold nuanced answers, moving into phrase, sentence and genre level, if and when required for knowledge capital. Punctuation is also explained as it can be used to clarify meaning-making. By Answer 3, links from the lexical (word) level are made to phrase level. In this section, noun phrases will be traced through, with their links to sentences and, eventually, genre.

Figure 4.47: Unfolding language at phrase level

The lexical and semantic items are taken from the Mechanical Engineering corpus, reinforcing, in turn, how each approach links together, without a hierarchy of use, but by need and application. This sustains the semiotic patterning of the MOG TREE system and teaches consistency of approach within a dynamic settlement system.

4.4.8 Creating the website at phrase level

In Figure 4.48, the opening page of phrase level concepts is shown. The individual entries can still be accessed via the key or head words as well, or by using hyperlinks within explanations.

Figure 4.48: Phrase level opening page

The second level of the website, therefore, moves into language-in-use. This is vital to show the complexity and dynamism of language and support the development of an idiomatic approach to language that encompasses the language of engineering and simultaneously develops an individual voice that is fluent and strong.

Figure 4.49 shows the grammatical structure of a noun phrase, using the metalanguage of grammar, with an authentic engineering explanation.

The order of adjectives/pre-qualifiers is a critical link and uses systemic functional linguistics to describe the order clearly and numerically. This is why not only the function of the adjective/pre-qualifier is described but also its typology, to show why the order of adjectives is as given. This increases the speakers' naturalness (idiologue) or fluency of the phrase/sentence and stops the work from reading like an English as a

Lingua Franca phrase (as found, usually orally, in *Chinglish*, *Singlish* and so forth), as requested in the needs analysis (Table 3.2, Appendix 4). Again, the phrase is taken from the language of Engineering to enhance familiarity and engagement. The parentheses are used to show that the additional information is optional but important or it would be located in a greyed out, development answer. Links take the reader back to the original explanation of the order of adjectives and its concomitant explanation of the detail of the terms.

Figure 4.49: Creating noun phrases

Having defined the type of phrase, it is important to understand the emotional, persuasive and functional nature of this type of phrase (Figure 4.50). Again, opening up answers is a choice, but each option also gives crucial information about lexical choice making for impact and persuasion. Using noun phrases is a vital part of the six stages of argumentation for introductions taught through English for academic purposes, genre-based writing courses. Here, the impact of each type of argument can be enhanced by controlling the language used in the smaller levels. The six types of argumentation are as follows:

1. Statements about the field, providing the reader with a setting or context for the problem to be reported and claiming its centrality or importance;
2. More specific statements about the aspects of the problem already studied by other researchers, laying a foundation of information already known;
3. Statements that indicate the need for more investigation, a gap, problem, or research niche for the present study;
4. Statements giving the purpose or objective of the author's study/its main findings;
5. Optional statement(s) that give a value or benefit for carrying out the study;
6. A map of the rest of the article. (Cargill & O'Connor 2013, p. 44)

Figure 4.50: The purpose of noun phrases. Using language for effect

Figure 4.51 considers the nature of quality engineering writing in more detail.

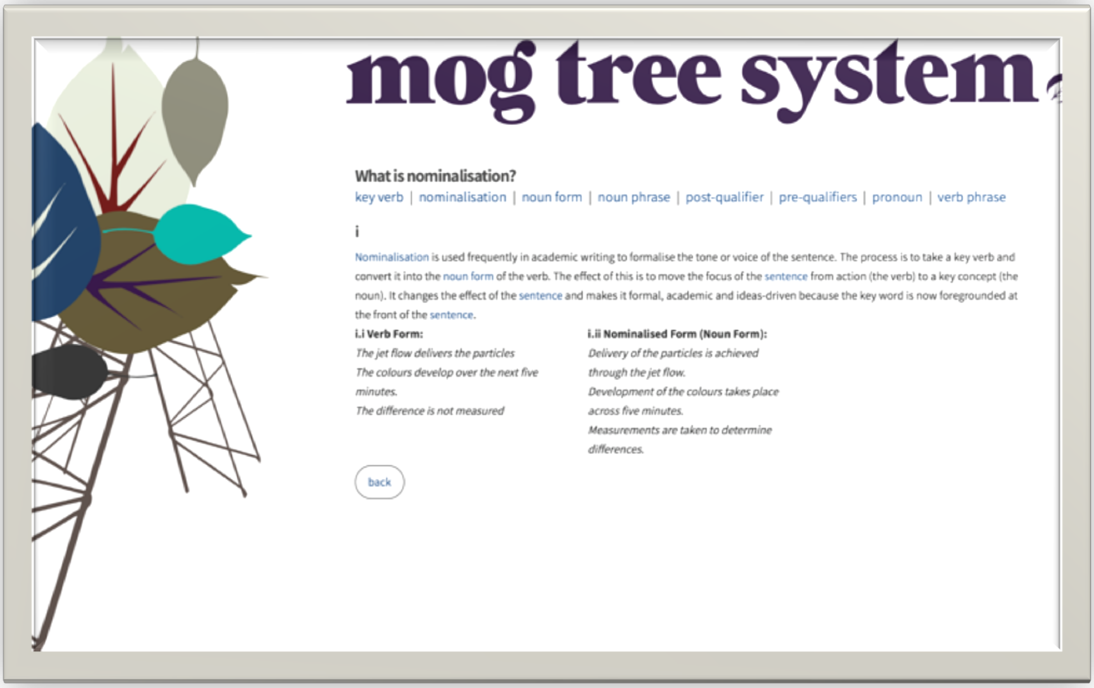


Figure 4.51: Nominalisation and its effects on writing

Nominalisation (Figure 4.51) is crucial as a tool for clarity and fluency in academic writing. It changes the balance of the sentence by making it conceptual rather than action-driven through the foregrounding implicit in both the word order and the structure. At this level, although issues of grammatical control are a central focus, so also are issues of style, which articulate with but are not strictly a part of grammar. However, for the user, the distinction is marginal, if not irrelevant. The layering format taken in http://www.mogtreeapp.com, across lexical to whole text or genre approaches, facilitates the inclusion of discussions of style, enhancing the relevancy of the website to the engineers, which is a vital part of its purpose.

4.4.9 Creating the website at sentence level

The next set of questions moves to sentence level, as in Figure 4.52.

Figure 4.52 Mogtree sentence level

In Figure 4.53, the metalanguage has morphed towards systemic functional linguistics, as the description is becoming more functional and fluid. Thus, both traditional grammar and systemic functional linguistics options are given to ensure access and inclusion. The dual layers of explanation also explain the relationship and nature of the two types of metalanguage. Response *ii* makes this explicit.

The questions after the systemic functional linguistics descriptors in particular are designed to support understanding of the relationships between and across the individual lexical items and show how meaning is generated both through word choice and combinations of word choices, giving a form of implied context to the sentence. This systemic functional linguistics approach reinforces the social nature of language learning and use and reminds writers of the interdependency of language and social context.

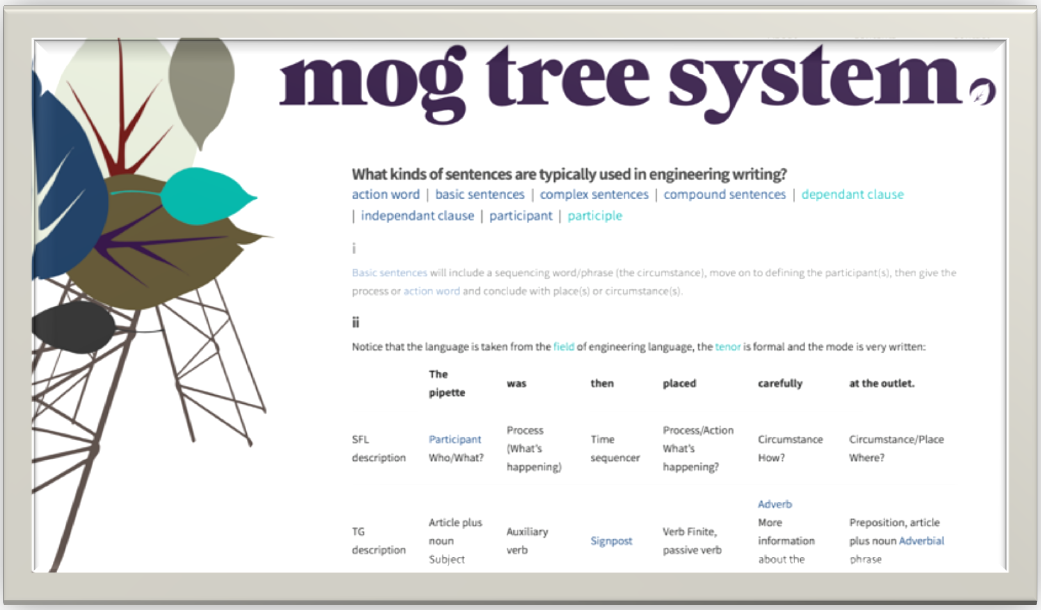


Figure 4.53: Parsing sentences using both traditional grammar and systemic functional linguistics

The use of tables is a significant problem in terms of HTML, as, although this mark-up language conventionally used tables to arrange the structure of webpages, recent developments in CSS override these characteristics, particularly in responsive and adaptive sites which permit percentage scaling and indeed wholesale replacement of layouts based upon screen size enquiries.

A working compromise was achieved, which makes use of the natively available column structure (text blocks with percentage widths) and lines drawn around their borders to suggest the grid format typical of traditional tables. These can then be rearranged adaptively (that is, in response to a coded interrogation) for different screen sizes, avoiding the visual chaos that would follow a more straightforward responsive solution, where control over column widths would be determined by simple percentages, rather than pre-planned organisations based on a variety of typical screen sizes.

In Figure 4.54, both traditional grammar and systemic functional linguistics descriptors are explicitly visible in the descriptions. The systemic functional linguistics descriptions are accompanied by questions in order to support the location of the function of the language item: the traditional grammar descriptions give the names of the items at both word and phrase level. This bi-partite, settlement approach (that is, an approach which uses both traditional grammar and systemic functional linguistics together, rather than as alternatives, where they offer the "best fit" to suit the needs of the reader/user) explicitly offers choice for those following the "more" button (read "iii", Figure 4.53):

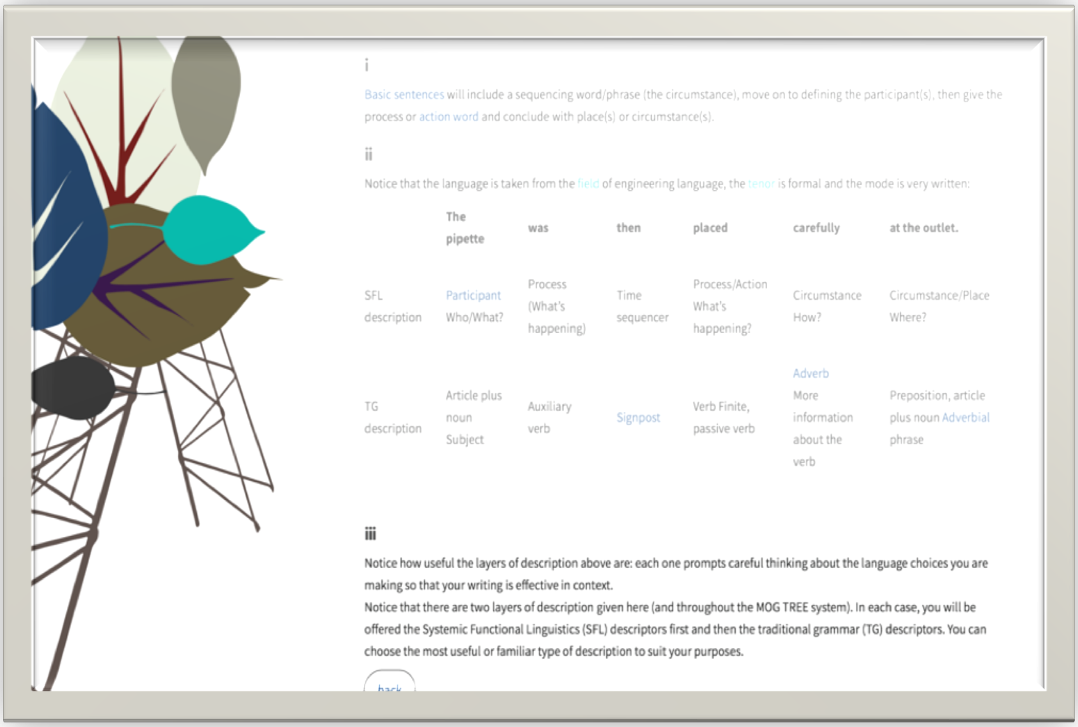


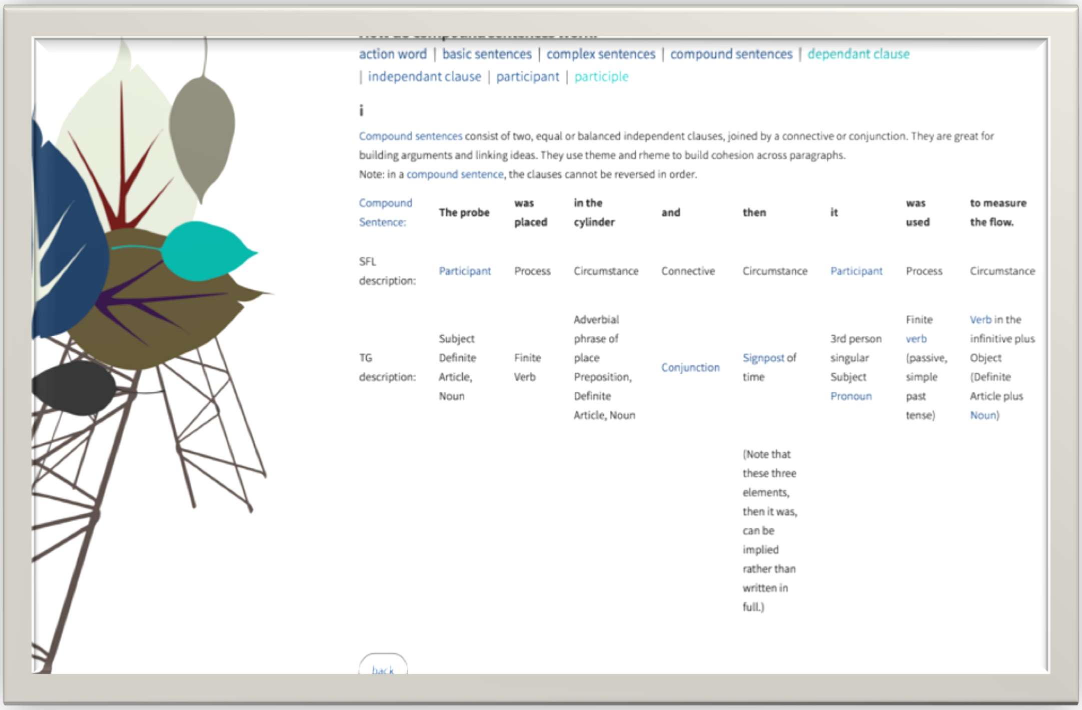
Figure 4.54: Examining the layers of metalanguage

At this point, the bridge across phrase, sentence and genre level is made overt as it is the genre level that justifies the choices at sentence level, which depend on those made at phrase level. Systemic functional linguistics is the dominant voice here as, at paragraph/whole text level, it is the most helpful approach.

This information then segues into a detailed examination of the creation of full text, with clear reasoning as to why particular choices should be made for effect. At genre level, the field, tone and tenor encompass every level from lexical item to paragraph and text construction in order to write in the correct form (academic writing), with persuasion and confidence (confidence in writing being vital for persuasion of the reader to the new paradigm). At this point, the reader or recipient becomes central to the writing: it is not just the message the author wishes to transmit that is vital, but the clarity of the reception of the message in the communicative transaction (Winsor 1990; Dowling, Carew & Hadgraft 2013).

All three types of core academic sentence structure are examined and explained (Figures 4.55, 4.56 and 4.57).

Figure 4.55: Mogtree simple sentences



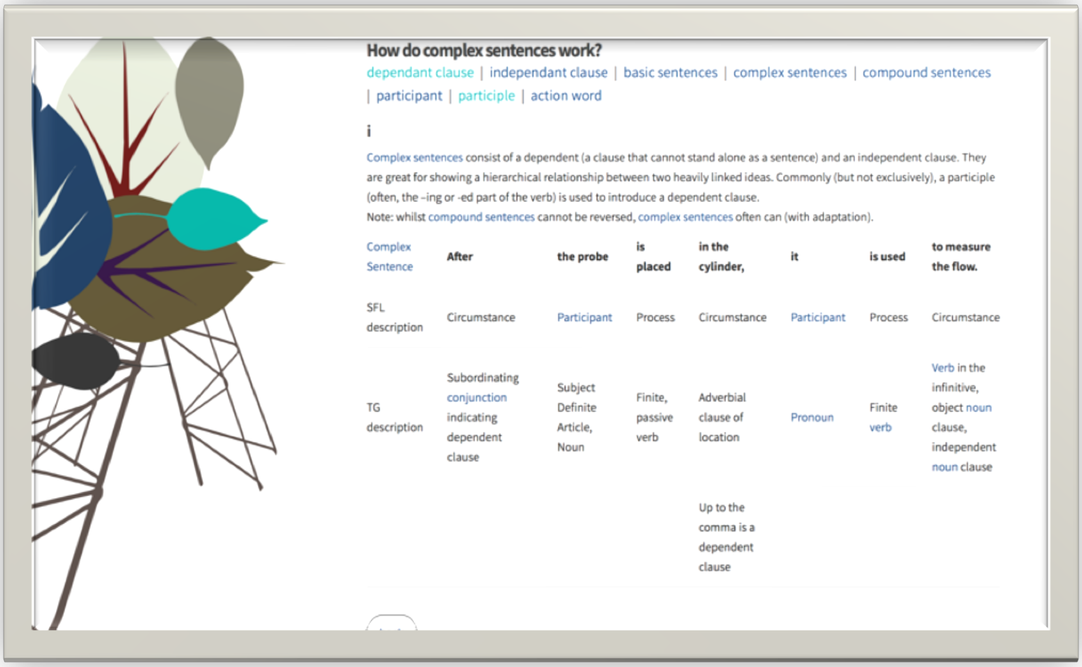
action word | basic sentences | complex sentences | compound sentences | dependant clause | independant clause | participant | participle

i

Compound sentences consist of two, equal or balanced independent clauses, joined by a connective or conjunction. They are great for building arguments and linking ideas. They use theme and rheme to build cohesion across paragraphs.
Note: in a compound sentence, the clauses cannot be reversed in order.

Compound Sentence:	The probe	was placed	in the cylinder	and	then	it	was used	to measure the flow.
SFL description:	Participant	Process	Circumstance	Connective	Circumstance	Participant	Process	Circumstance
TG description:	Subject Definite Article, Noun	Finite Verb	Adverbial phrase of place Preposition, Definite Article, Noun	Conjunction	Signpost of time	3rd person singular Subject Pronoun	Finite verb (passive, simple past tense)	Verb in the infinitive plus Object (Definite Article plus Noun)
					(Note that these three elements, then it was, can be implied rather than written in full.)			

Figure 4.56: Mogtree compound sentences



How do complex sentences work?

dependant clause | independant clause | basic sentences | complex sentences | compound sentences | participant | participle | action word

i

Complex sentences consist of a dependent (a clause that cannot stand alone as a sentence) and an independent clause. They are great for showing a hierarchical relationship between two heavily linked ideas. Commonly (but not exclusively), a participle (often, the -ing or -ed part of the verb) is used to introduce a dependent clause.
Note: whilst compound sentences cannot be reversed, complex sentences often can (with adaptation).

Complex Sentence	After	the probe	is placed	in the cylinder,	it	is used	to measure the flow.
SFL description	Circumstance	Participant	Process	Circumstance	Participant	Process	Circumstance
TG description	Subordinating conjunction indicating dependent clause	Subject Definite Article, Noun	Finite, passive verb	Adverbial clause of location	Pronoun	Finite verb	Verb in the infinitive, object noun clause, independent noun clause
				Up to the comma is a dependent clause			

Figure 4.57: Mogtree complex sentences

These three sentence types (simple, compound and complex) are the core of all academic writing: they express the six stages of argumentation mentioned above and all other structural forms typically found in Engineering writing. Mastery of the fluidity of the sentence types is a key mechanism in writing fluent, nuanced, academic writing. By considering and gaining ownership of the elements of these three sentence types, confidence and accuracy is considerably enhanced. Such training should also enhance clarity as the teaching naturally lends itself to shorter, clearer sentences and nuanced control of cohesion through control of the various forms of theme and rheme.

4.4.10 Creating the website at genre level

The website now moves to genre level thinking, as shown in Figure 4.58, below.

Figure 4.58: Mogtree genre level

Although there are only two sections here, the type of information on offer is sophisticated and complex (Figure 4.58). It leads directly to English for academic purposes teaching and should support genre-based learning significantly, once the metalanguage has been mastered and owned. Figure 4.59 shows how the website supports the selection of an appropriate register.

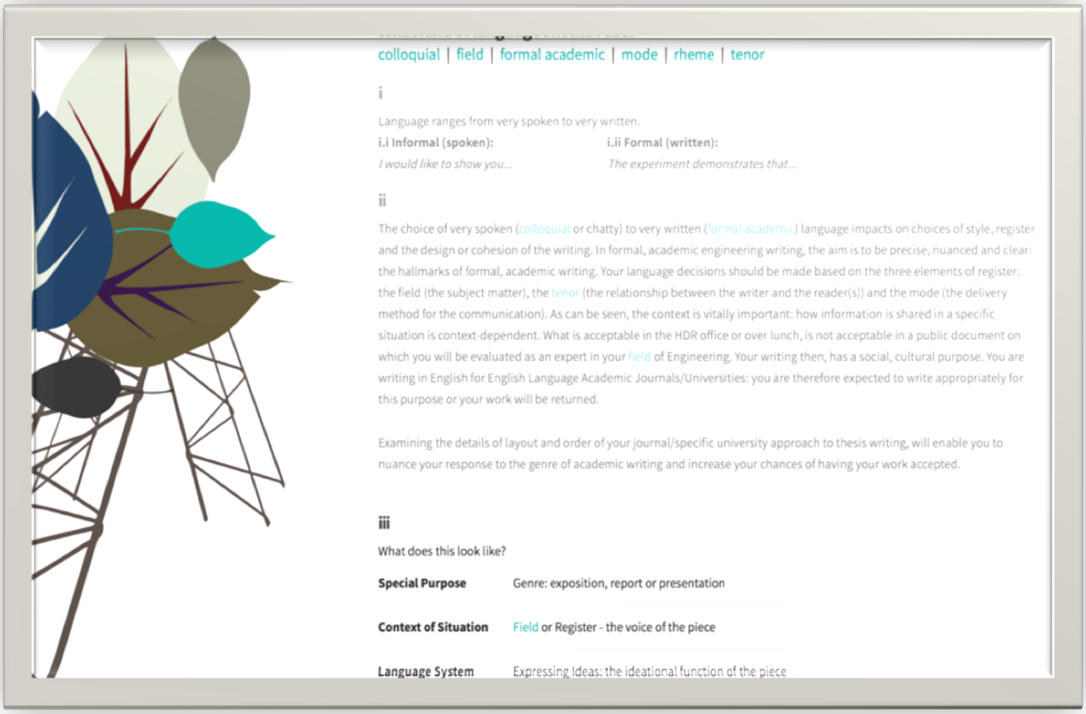


Figure 4.59: Selecting formal, academic language

The description in Figure 4.59 is deceptively brief as it contains the core requirements of good writing and should offer a helpful summation of the other levels and previous learning: or a strong prompt for those who land here without following the other, more detailed pathways. The twin concepts of very written and very spoken language are essential to language control and writing to purpose.

These sophisticated skills are explored through the Engineers Australia requirements of undergraduates, indeed taught explicitly at the University of Adelaide, School of Mechanical Engineering at undergraduate Levels 1 and 3, but often not taught explicitly to international students during undergraduate study overseas. By making the three areas of register (field, tenor and mode) overt through the teaching, the students are enabled to recognise the nature of their language choices and supported to make strong, academic choices. Again, the more button is vital to enable students to explore this complexity at their own pace.

By making the website searchable (either manually via the Index, or by using the contextual indirect links or header words, which encourage tangential and contextual exploration), it is possible to trace threads such as nouns across from initial description through compounding into noun phrases and through into full sentences and paragraphs, understanding the impact of each choice at each level. Such control enables students to write more succinctly as information, ideas and explanations can be given in the most cohesive form possible without the inevitable repetition that comes from a lack of confidence that the message will be received as intended. In this sense, the tool enables direct access to the recipient of the message, avoiding the negative gatekeeping that is invoked by use of English as a *Lingua Franca.*

4.4.11 Creating the website for punctuation

As suggested earlier, punctuation is not normally included within the teaching of grammar; however, the needs analysis (Table 3.2, Appendix 4) shows that the EHDRS perceive it as part of grammar. It is included at their request. It is without question a form of meaning-making and so it is a valid inclusion in the MOG TREE system.

As can be seen in Figure 4.60, the approach taken is focused strongly on function to enable punctuation to be used sensitively and concisely, enhancing cohesion.

Figure 4.60: Introducing the function and purpose of punctuation

The order of punctuation is vital as it gives control over the types of pauses and hence pace. So, for example, the use of semi colons and colons is also critical and links to signposting and cohesion as they can be used to replace connectives, whilst making the structure explicitly visible and avoiding comma splicing by understanding the true function and purpose of commas is a mechanism for enhancing sentence length control and selecting the pause required for all phrases in parentheses. By including these elements, it can be seen that punctuation is a key part of writing confidently, with purpose and effect, which is essential for all engineering writing (Figure 4.61).

Figure 4.61: The pleasure of using http://www.mogtreeapp.com

4.4.12 Results

There were two workshops offered to consider the contents and form of the website before it was created online. The first, prior to the development of the synergetic systems engineering tool (http://www.mogtreeapp.com), invited the students to consider how grammar can be used to problem-solve language issues and check whether this skill was seen as important. This is a clear instance of where the spiral system enables the students to take an active role in determining the research direction. The results for the question "*How useful is the teaching of grammar as a discrete course?*" affirm the need for a separate, interactive grammar support system (Tables 4.6 and 4.7).

The students were asked the open-ended question "*Would knowing about grammar have helped you to edit your own work?*". The data recorded in the workshop semi-structured interviews showed that the students felt that: a) knowledge of grammar made it easier to make the words flow, b) that knowledge of grammar is essential for self-editing as it gives control to the user, c) that a grammar workshop still had limitations as the level of facility with grammar limited the accuracy of the writing and d) that grammar alone is not sufficient to ensure natural language use. This final part is very true and perceptive: it is why there are three parts to the solution, as each works in balance with the other.

The findings supported the construction of the synergetic grammar tool and provided elements to address within the construction of the tool: hence the development of the pathway function through searchability, the layering of information from word to phrase, to sentence to whole text level and the focus on collocations, or how words are put together to make those movements across the levels. It is clear that knowledge of grammar alone is insufficient. This is addressed through the other two parts of the tri-partite solution.

The EHDRS were also asked a short series of questions using a 7 point Likert scale for their responses, as in Table 4.6.

Table 4.6: Responses to the question: "How useful is the teaching of grammar as a discrete course?"

(N=5) (Likert scale: 1 = not useful. 7 = extremely useful.)

Pre-teaching of basic grammar course Responses in %	1	2	3	4	5	6	7
Positivity		20	20		20	40	
Usefulness of Grammar				20	20	60	
Engagement					60		40

The results suggest that there is broad agreement that a basic grammar course, coupled with a grammar tool, would be positively welcomed (60%), useful (100%) and engaging 100%). Those who were unsure about the grammar tool were concerned that it would replicate *Grammarly* (2018) or that it would add to their workload. These are valid concerns. Language development takes time. The tools developed here are designed to make time used on language development efficient, but they cannot obviate all learning time. The synergetic systems engineering tool does not attempt to replicate *Grammarly*: it is designed to go beyond it by giving both discipline-specific advice and enabling deep understanding of the reasons for choices. The next question considered the usefulness of grammar (Table 4.7).

Table 4.7: Responses to the question: "How useful is the teaching of grammar as a discrete course?"

(N=4) (Likert scale: 1 = not useful. 7 = extremely useful.)

Post-teaching of basic grammar course Responses in %	1	2	3	4	5	6	7
Positivity					50	50	
Usefulness of grammar					25	50	25
Engagement					75	25	

After the basic grammar course had been taught, the students were asked the same questions again (Table 4.7. Note that one student had to leave for a supervision meeting). This time broad agreement for all three elements (positivity, usefulness and engagement) was 100% in favour of the synergetic systems engineering grammar tool, suggesting that the workshop was useful both in terms of the grammar taught and the reasons given for the teaching.

Clearly the grammar tool needed to address the issues identified in the open-ended questions in the needs analysis (Table 3.2, Appendix 4). By using both systemic functional linguistics and traditional grammar, as in the workshops, contextual language learning can be supported to refine understanding of language in context. Participant 002 commented: "*Although I don't really want to spend time learning language about language, I can see that it works as a useful shorthand*".

Boolean language was used to reinforce the need for selection of language from the whole field of possible language choices and the detailed approach enabled students to narrow that field down for specific instances of language.

The engagement levels were high and the focus on language led to a wider engagement with language issues. This engagement is vital as it leads to flow (Csíkszentmihályi, 2008). Flow is a state of positive engagement with work, to the exclusion of all distractions and vital for ensuring deep learning.

In the second workshop on the synergetic systems engineering tool, the EHDRS considered both the content and the intuitive nature of use of the website, for when students either go beyond the workshops and use the website individually or use it without the training workshops.

At this stage, however, the website contents only existed as a linear set of draft questions and answers for consideration. As with the language trees moving from 2D drawings to 3D architecture, the website was re-conceptualised as a non-linear, searchable, multi-pathway site in order to enhance its usefulness and benefit from the technology used in its creation.

The content of the website was designed to respond to the student needs identified after the basic grammar workshop. Its purpose is to enable quality self-editing, thereby saving supervisor time and increasing skills and confidence in the student.

It was envisaged that this tool would be used after the other two tools, in the refinement stages of editing. It asks and answers questions containing doubt (or nuance), just like having one's own personal editor in the room. This is why it depends on Boolean logic. Participant 002 expressed a common desire for language learning to be more straightforward: "*I wish language questions would have just one answer. It would be so much easier to control*". The purpose of the synergetic systems engineering tool is to bring this possibility closer by making knowledge capital of grammar deeper and more accessible.

Figure 4.62 shows one of the original pages from the paper format of the grammar tool, shared with the EHDRS. The question format is highly visible and repeated throughout the document. In the final version, the questions remain most clearly in the indexing, being largely implicit elsewhere. This is because it became clear that the content needed to be reduced in order to avoid overwhelming the screen size, particularly when viewed on a mobile phone. Participants 001, 002 and 004 all complained in the workshop: "*It's too much to read easily on a small screen*". The question format is retained where possible, however, as it suggests a personal dialogue between the user and the creator of the website, offering personalised pathways through the website, so information is given at the point of need.

To optimise learning, therefore, the unfolding of information through the search functions complies with the needs analysis request for everything to be succinct and easily accessible in as many formats as possible (Table 3.2, Appendix 4).

Question 1: Is a verb needed in every sentence?

Response 1: In formal, academic writing, a finite verb, i.e. a verb in a tense, is needed in every sentence. Sentences without verbs are known as journalese or sentence fragments. They are only acceptable in mass media, very spoken sentences and informal or colloquial language situations.

Question 2: What are the types of sentences used in academic writing?

Response 1: There are three types of sentences used in academic writing: simple, compound and complex. No one type of sentence is better than the others: a well-balanced article will use a judicious mixture of each type.

Response 2: Sentences consist of an independent clause (a clause that will stand alone, grammatically): they consist of a subject, a finite verb and (possibly) an object (in TG) / a participant, a process and (possibly) a circumstance (in SFL). They are useful for making strong statements and for clarity.

Simple Sentence:	**The probe**	**was placed**	**in the cylinder.**
SFL description:	Participant	Process	Circumstance
TG description:	Subject Definite Article, Noun	Finite verb (passive, simple past tense)	Prepositional phrase of location Preposition, Definite Article, Noun

Figure 4.62: A sample of the original form of the synergetic systems engineering tool

Throughout the discussion in the workshop, the EHDRS were interested in the content and its form. They felt that the content matched their needs closely and they were clear that there needed to be a way of navigating that would allow for individualised pathways through the material on offer. The EHDRS were shown the texts used in researching the grammar terms and felt that the language used was: "*respectful*", "*adult*" and "*clear*" (Participants 001-003). Ultimately, the descriptions were a little too driven by systemic functional linguistic formats, so in the final version, more detail of traditional grammar was given at word level. Participant 001 commented: "*I can see the systemic functional grammar is useful for phrases and sentences, but most of my mistakes are individual words in the wrong place: more detail about traditional grammar would perhaps help me more*". In the final version, the traditional grammar detail is clear, succinct yet detailed.

The EHDRS considered the brand guidelines and style sheet that had been developed. Overall, there was strong support for the typeface chosen. Participant 004 commented, "*It's a nice clear print. I can read it easily, even though I'm dyslexic*". However, they were more interested in the coding issues, which are relevant to their engineering expertise. They saw the questions in the original format as logic gates, and this was indeed how they were used through the coding process.

The following elements were presented and given broad agreement: graphic elements, graphic type elements (brand lock-up), typography (headings, body copy, hierarchy), placement of primary copy, colour (specification for use in HyperText Markup Language (HTML) and Cascading Style Sheets (CSS)), main navigation bar (including key word search detail) and contextual navigation (more/back buttons). Participant 004 commented: "*Yes, we like this. How will it be coded?*" The issue of how to achieve this, within both budget and time constraints, for both Android and Apple operating systems (IoS) was what led to the decision to create a website and not an app.

The website has had a number of beta test runs, from its paper to its online iterations, as it has evolved. Harnish (2018) was used as a professional approach to the structuring of the semi-structured interviews undertaken. Issues and comments have been considered as they have arisen and solutions built into the current form of the website, ready for the wider testing through the Product workshops.

The n-number for this testing was sixteen overall, with a mixture of engineers (from Mechanical, Petroleum and Software) in the testing group. Of these, nine are EAL/D, two are L1 English speakers and five are bEAL/D students. The number attending each workshop varied significantly. The exact number completing the feedback is given for each section of the responses. Two further reviews of the early versions of the website were solicited from EAL/D Engineers and their comments were also taken into account.

The Product Workshop (Spiral 3) should clarify even further when to use which part of the tri-partite system, though repetition of information in different formats is reported as useful, as it individualises use. Whilst some of the students have an entrenched view that one solution is ideal, the majority of users agreed that the multi-faceted complexities of language use benefit from a multi-faceted solution.

The EHDRS felt that the design was audience-appropriate, with the language clear and relevant. A number would have liked more examples, which is perfectly possible when greater amounts of coding time become available. This was asked for in both Spiral 2 and Spiral 3. Originally, prior to presenting the grammar tool to the EHDRS, there was a plan to include self-test of writing in the website, but in terms of coding the potential number of variables, this was too hard and so such tests were built into the Product Workshop using a paper copy of the questions, which were then marked by hand.

All the EHDRS are familiar with Information and Communication Technologies and had no issues with adjusting text sizing to suit individual needs. They felt the font sizes were acceptable once the number of words was cut down, and the fonts themselves were engaging and readable.

The logo uses a font called *grumpy*, designed by Tomi Haaparanta, and released in 2011. It is a heavy, high contrast serif. It is inspired by a design by William Caslon (1692-1766), giving it a long humanist history (Wikipedia 2017). This means that the typeface is both playful and highly legible, both strong requirements for this website. There is a slightly 1970s retro feel to the width and shape of the letters, which is particularly fashionable. It was also chosen because its character seemed strong enough to use as a type lockup (that is, type as logo).

The whole of the rest of the website is set in various cuts (mostly light) of *Source Sans Pro*, designed by Paul D. Hunt, under tutelage from Robert Slimbach. It was Adobe's first open source typeface family. It draws on the clarity and legibility of twentieth century American Gothic typefaces (Wikipedia 2017). This face was created for screen use (it has special coding called hinting to make sure it renders well on a wide variety of screens). It is a sans serif (so a suitable foil for the serif of the masthead) but it has some variations of line width which offer the character needed to make a good pair with *grumpy*.

As an open source typeface, coders can not only use it but see how it is built and offer changes and corrections. Open source works on a collaborative assumption and is never intended to be definitive. This seemed appropriate to a learning environment. Furthermore, to explain why it makes sense to return to an unfashionable early twentieth century form when designing type for screen: the humanist type has a variable width line which is easier to read than the true, geometric sans serif fonts celebrated by Swiss Modernism, which held sway in design circles for most of the twentieth century. This is particularly the case on screen, where the squaring off caused by low resolution screens until recently made geometric fonts all but illegible on the web.

4.4.12.1. **Content findings**

The website copy was seen as informative by all participants. The EHDRS particularly liked the way the examples came from engineering. This was commented on repeatedly across the workshops. The text is broken into easy-to-read sections, although further refinement of the copy spaces is possible at a later date. Currently it does require scrolling for some elements when viewed on a mobile phone (although not on a laptop or tablet because of the screen size). The EHDRS did not, however, feel that this interfered with the accessibility of the content. The question form used to share ideas was reported by the EHDRS in discussion to be friendly. The definitions are seen as helpful: a full glossary will be included later, when coding time is less of an issue. More examples were requested. Some more have already been included and even more can be included later.

The EHDRS reported that the links enhance the process of locating information and support skimming on multiple readings of the information given. Participant 003 commented: "*I liked the way I could find my own way through, looking up just enough for what I needed*". Whilst there was one counter voice on this, Participant 011: "*The link "more", for example, on the page - is it possible to link more than one noun together?*" (to which the answer is refer to:

http://www.mogtreeapp.com/categories/word_level/nouns/is_it_possible_to_link_more_than_one_noun_together/).

"*There are "i" and "ii" buttons to unfold information. Users need to click on "more" to read the content under "ii". But some users may neglect the link "more" so they will miss the content under "ii". I think it may be more clear to just show the content under "i" and "ii" at the same time*". Whilst this danger does exist, the general consensus was that the drive to enable individual pathways was stronger than the need to display all the potential information at once.

By using the participative action research spirals in the research design so that each element is considered iteratively across the whole project, the EHDRS have been able to review the website at regular intervals as it has been created, giving a sense of ownership to the study groups. The feedback was positive throughout Spiral 2: for example, Participant 012 commented: "*Overall, I think it is a pretty nice and useful place to go when we are lacking the basics of academic writing*" and Participant 011 observed: "*I will browse the website very often in future because it's very useful for me. If I find there's something I need to share with you, I will let you know promptly*". This indicates an engaged sense of ownership amongst the EHDRS for the website.

4.4.12.2. **Accessibility of the website**

By choosing to use a website, it was ensured that the content can be accessed by those with a range of disabilities. The visual nature of the work appeals to those who are hard of hearing and those with dyslexia can change the font size, return to the text and value its succinct format. For those with visual disabilities, the website can be heard by using the adaption available through a Google Chrome add-on, which "reads" the website to the user.

EHDRS with other disabilities (such as physical access to the machine) should be able to overcome their specific challenges/divergences through the use of supportive technical hard and software, so the site itself should be accessible to all postgraduate students who choose to use it. The EHDRS felt that this level of support was appropriate and probably sufficient for the cohort.

One dyslexic student wondered if there could be more diverse graphics (for example, animated visual descriptions of explanations). Whilst it would have been interesting to use more image-based work and to include sound versions of each element, voiced by a human rather than a computer, this task proved impracticable at this juncture of development. A human voice would have given an additional level of learning support for international students, but the level of additional coding left this luxury outside the scope of the initial research project. This, therefore, comes into the Future Work section of the thesis, once a business partner has been located.

4.4.12.3. **Google rankings**

The name of the language learning system, MOGTREE, is used within the name of the website, as it makes the system visible via any search engines, particularly GOOGLE. It is findable by the target audience, and all those interested in a grammar site for engineers, via the sub-heading, which explains its purpose. In addition, the website will be presented within all engineering writing courses in the School of Mechanical Engineering, at the University of Adelaide, as well as through conference presentations such as those for Australian Association for Engineering Education.

Once fully tested, it can be disseminated through other portals, such as the Mechanical Engineering Writing and the Barr Smith Library, at the University of Adelaide, intranet pages. In this way, it will be possible to build an image of the impact of the website for research purposes and ameliorate it with through the feedback received in class, via surveys and via the contact form on the website itself. It is currently available through Amazon, the website host. Current usage (as at 05.01.18) and predicted usage rates are in Table 4.8.

Table 4.8: Using http://www.mogtreeapp.com usage rates (Amazon AWS analytics) as at 05.01.18

AWS Service	*Current Usage*	*Forecasted Usage*	*Free Tier Usage Limit*
20,000 Get Requests of Amazon S3	2423 Requests	75113.0 Requests	20000 Requests

"This alert is provided by AWS Budgets. To unsubscribe from these alerts or to change the email address to which you would like your alerts to be sent, please visit Cost Management Preferences."

4.4.12.4. **Platforms**

The website is adaptive and responsive across mobile, tablet and laptop screens, with this flexibility built into the design from the outset. This is very important as a mobile is often used for searching quick answers with a document remaining open on the laptop or desktop screen. This requirement also means that the site has to be accessible across operating systems, which is why it is actually a website, even though it was originally envisaged as a native app. Creating a multiplatform native app. would have required significantly more coding, which, in addition to the complexity generated by the content itself, was deemed impractical and inappropriate for the purpose by the wider team.

Thus, the division between the content and the navigation were examined carefully. There are clear navigation buttons, including more and back within the body of the text. The menu bars are conventional and so easy to recognise. The number of elements has been minimised to promote facility of use. These elements all achieved broad support within the workshops, with more discussion about the indexing features. Whilst having multiple indexing features would have been helpful, it was felt that having three (an index page, internal hyperlinks across words and itemised key words) was sufficient in the first instance, to avoid feature creep. This was confirmed in the workshop discussion by the repeated comment: "*If it's not easy to use, we won't use it. Grammar is already hard enough without distraction*" (Participant 003).

By making it a website, the ease of access and functionality is increased. The workshop students felt they could locate it successfully and that it was quick and easy to use. Participant 002 explained: "*We use computers all the time, of course this is easy to use*". There are still some questions pertaining to the development of the planned expanded navigation and index pages but what has been produced to date is a pragmatic solution and has presented no difficulties to users in any of the workshops.

In the first tests of the website itself, comment was also made on navigation. Participant 012 commented: "*Anyway, I just browsed the website and had a few tries on different links (both in about and categories) and I think they are all working perfectly fine and I don't see any errors. The website itself is quite easy to use and everything seems clear and well organized to me. The frequently asked questions (if that's what they are) in categories all look very helpful, and probably I don't know the answers to half of them, I think I will spend some time on these questions*." This positivity will certainly enhance use, which is vital to embed the website into learning practice.

All students to date have reported positively on the website. Detailed analysis of the Product Workshop (Spiral 3) findings are given in Chapter 5.

4.4.12.5. **Navigation**

The depth of the site has been addressed by the use of hyperlinks within each element, so that searching is as quick as possible to enhance engagement. The opportunity to investigate in great depth is offered via the "more" buttons and hyperlinks, but simple answers are searchable within one or two clicks, with the user choosing to search further if they are drawn into the detail of the answer. This avoids the time-lag which generates impatience and rejection; it also avoids outfacing the clients/users by offering too much information in one search. Whilst all pathways are open to the user, engineers typically have very succinct questions and the answers. Therefore, it was necessary to match this need, whilst offering further opportunities for those who engage in more detail. To date, the approval rate from the workshops is high for the speed and stability of the site. Only when it is tested by larger groups online will any stability issues become visible.

The site does not use complex coding without universal browser support such as Flash (which is not supported on iPhone or iPad, for example) within its structure. This was a definite choice to increase access, especially on mobile phones, or where students may not have access to the latest technology. Ease of access was a critical driver of all choices with this site in order to support intuitive use.

The responsiveness to click feedback is also crucial: the response time of about 0.1 seconds (effectively, immediately) is vital to encourage use. Slow response times lead to rejection of websites by users. Stylistically, all clickable systems indicate their nature through the use of colour which makes them immediately accessible. The participants have responded positively to this question to date.

Readability was also a critical driver in the design brief. Clear whitespace enables each page and each pictorial or typographic element to breathe by avoiding overcrowding on the page. The colours link with the other two parts of the system to enhance learning across the three parts of the language solution. The colour contrast is high, and the colours are bold and gender neutral to reflect and offer familiarity through repeatable identification to the typical user.

A number of the students approved of the visual design. They felt the simplicity of the tree enhanced the look and that it was clear and easy to read. This is very positive, as it is critical for use.

The purpose of the website is given on the home page, along with links to the other two parts and a supported concordancing website (antconc.com 2018). These open in separate pages to avoid losing the home page during navigation. Attention is drawn to the feedback page on this home page to make it clear that there is a human level of interaction available within the site, making clear that it is part of a research project as well as a potential solution in its own right. The site is searched through key questions and hyperlinks to associated answers. Each element is both named, using full navigation for lap and desktops, and by the traditional hamburger linkage or menu symbol (☰) for tablets and phones, so that the elements can be found simply and intuitively, using international designs for each part.

The EHDRS reported that they liked the way the website has an interactive feel, both in terms of its pathways structure and the opportunity to give and receive feedback from the author. They felt that the comment sheet is simple and clear, reflecting the open nature of the design and ensuring that the users always have a voice (Figure 4.63). Such feedback is vital for future developments, as they indicate what is being done effectively, as well as where changes could potentially be made.

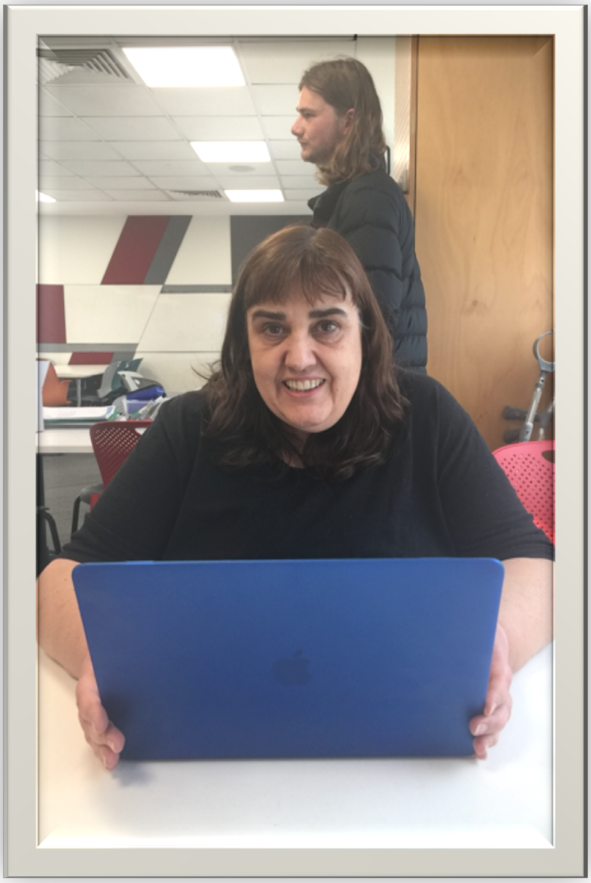


Figure 4.63: A postgraduate working with the grammar app. as part of a team.

4.4.13 Summary and Conclusion

This section shows the development of the mogtreeapp.com website, from conceptualisation to production online. It links each element of the website to the needs analysis (Table 3.2, Appendix 4) and the Spiral 2, Prototype Workshop, giving it authenticity and a robust framework. Whilst EHDRS are highly visual, tactile learners, by combining a strong, visual UI with the familiarity of a website, the grammar tool is fully aligned with EMoCs as well as learning needs.

The Spiral 2 Prototype Workshops have all fed into the development of the website, to create content and design that are strongly targeted on the particular needs of this special cohort of learners, making this an original, user-orientated piece of research.

4.5 Chapter Conclusions

4.5.1 Outcomes from the Prototype workshops

The needs analysis (Table 3.2, Appendix 4) produced a very clear set of answers to the question: "*What support do you need with your language skills?*" (Appendix 4). The answers ranged from practical help with editing and grammar to emotional support with the business of writing. These elements were all built into the product.

The writing samples showed a clear range of error types, suggesting that help is needed at word, phrase, sentence and paragraph level. By judicious selection from both traditional and systemic functional support systems, this was achieved. They also revealed L2+ EHDRS have particular issues with article use and collocations. Support was offered through the use of data-driven learning systems.

The language trees were regarded as useful for supporting self and group editing. Some design issues were raised for resolution. They do not solve grammar or collocation issues, but they do support social learning and self-editing successfully.

The Mechanical Engineering corpus received mixed reviews, but there was interest, particularly from the bEAL/D cohort, for which it is most appropriate. The corpus assumes knowledge of grammar but it also offers concrete support for collocations in the privacy of a virtual environment.

The grammar tool was regarded with warmth and useful design details and parameters were established. The EHDRS found the grammatical explanations accessible and would have liked more examples throughout, as they felt they were helpful.

The idea that the tri-partite solution could be used both in its parts and as an holistic approach to editing was received well by most EHDRS. Whilst there was some emotional resistance to having a multi-part approach, the EHDRS recognised that each part was a specialist approach to part of the problem and that the solution would be stronger for having all the elements available and ready to articulate to individual need at the point of use.

By revisiting and reviewing the data through each set of workshops (Discovery and Prototype, to date) using the participative action research spiral, or iterative approach, answers to key questions evolved and the EHDRS could see their ideas being adopted and designed into the final products. This supported their engagement and ensured that their views were heard and valued.

Product testing of the solutions, both individually and as a whole, demonstrating both their evolution and key design features, was essential to check the faithful reflection of the EHDRS' requests in the products and to bring the products to a wider audience again. The Product Workshops are described in Chapter 5.

The workshops had some serious issues in terms of attendance, consistency and persuading the students to write about their responses, however, they also retained engagement and offered insight into the ways in which engineers learn, which conform strongly with the literature. Having demonstrated earlier the pre and post comments by the EHDRS about the MOGTREE website design, a strengths, weaknesses, opportunities and threats (SWOT) analysis was completed within the workshop, with participant input and agreement (Table 4.9) in order to assess the outcomes achieved in terms of research design. Further, summative testing is shown in the next chapter, using the live website.

Table 4.9: Conclusions about the Workshop design in Spirals 1 and 2, the Discovery and Prototype Workshops

Strengths	Weaknesses
• Workshop format keeps focus group together • Regular meetings give shape and consistency • Incorporates elements of time passing to see effects on their writing as well as responses to teaching • L1 and T1 students were together throughout and felt more comfortable that way • Workshops keep control of the design materials, which may be patented later	• Poor attendance after the Needs Analysis and Writing Samples (from 16 to as low as 4) • Too long a cycle: pace was lost • Competing elements win – there are always more workshops • Repeat workshops (in an attempt to boost numbers and data) led to slack attendance and variable learning and teaching conditions • Lack of supervisor drive to attend • No control groups were possible • New focus groups did not materialize as numbers were too low • Written detailed data was hard to obtain: it needed to be recorded by the researcher in many cases
Opportunities	**Threats**
• Can revisit and ameliorate issues in subsequent Spirals • Need to increase numbers if possible • Need to increase data streams • Can learn from weaknesses, notably in questions and use of recording of data • Build in some control testing if possible	• Ethics issues in any revised research design will cause more delays • Drawing participants from beyond Mech/ECMS may muddy the data • One strong character can influence many to withdraw (as happened with concordancing) • Patent issues and costs • Disengagement by some academics, means there is a lack of active support for writing in some places • Continued lack of active supervisor support

Strengths: from the analysis, it is clear that having results over a passage of time is beneficial, as the EHDRS could use the materials and think about them over time. This reflection fed into their responses and hence the direction of the research.

Weaknesses: the period of time covered was an issue for the students. Having spent significant time on Spiral 2, it was clear that Spiral 3 needed to be as compressed as possible, without being rushed.

Opportunities: it would be useful to build in control groups, but realistically with such small numbers it was important to reach out to as many students as possible. Future work could usefully include exit interviews with those who complete or who leave the PhD programme to investigate their perceptions of the impact of language issues, however this would be a significant project in its own right and would need its own ethics clearance, so it falls outside the scope of this thesis.

Threats: it continues to be important to work with individual academics to build support for the language workshops, to secure base support and develop ever more positive relationships. As a result of this analysis of the research design, the following issues are raised for resolution in the Product Spiral:

- The need for new questions
- The need for more data
- The need for these data streams to go beyond repetition and deepen analysis
- Better targeting of the elements and the solution as a whole.

To date, the evidence suggests that the three parts of the MOG TREE system have merit in terms of securing learning and well-being for EHDRS at the University of Adelaide. Prior to the Product Workshop the adjustments suggested to each of the three elements were made, testing booklets were generated to secure learning and perceptions of learning. The EHDRS were invited to the final workshop in the sequence to consider the working versions of each element individually and holistically.

This new set of research considerations were used to generate stronger and more effective links between and across affect and effect of the learning. The Product workshop invited both commentary and numerical data using Likert scales in order to clarify and quantify the data gathered. New questions were designed in order to deepen the level of knowledge gained from the workshop. The questions were designed to elicit reactions to both individual and grouped elements of the solution.

In the Chapter 5, Spiral 3, the final Product Spiral, is evaluated. It involves presenting the system to a workshop of EHDRS, who then considered the efficacy of each element of the final (to date) versions of the tri-partite MOG TREE system first separately, then together.

Chapter 5.
Spiral 3: The Product Workshop

5.1 Introduction

Spiral 3 of this participative action research (Cohen, Manion & Morrison 2013) consists of testing the English language learning tools both individually and as a set, following the theory, design architecture, pre-testing and production phases in Spirals 1 and 2.

The chapter offers description and analysis of the setting up of the workshops, which contained roughly forty percent of the participants who had attended at least one of the earlier workshops and some sixty percent who were new to the MOG TREE system. The survey development, recruitment processes, format of the workshops, along with the development of the formal teaching materials, are also shown and discussed. The analysis covers what was tested and why for each element, in terms of how the participants responded at both an academic and an affective level.

5.2 Scope

5.2.1 The participants

Invitations went out for the workshop via the HDR email group in the School of Mechanical Engineering, as well as through the lists held centrally of all those who have undertaken CaRST courses for Writing in the School of Mechanical Engineering (thereby encompassing a range of engineers from across the Faculty of ECMS). Some of the participants in the earlier workshops came along to see the latest iterations of the products they had been part of developing, which was very pleasing. More than half of the workshop participants were new to the tools that had been developed. This gave a good balance of those who were familiar with many aspects of the tools and those for whom all the theory and practice was new.

Throughout the testing process, it has been very difficult to obtain a stable group of participants. This time, the workshop was advertised as sitting within one four-hour slot rather than running across a year and a half, with the encouragement of CaRST hours being available for those who attended. The EHDRS were also promised cake, and rumour has it that it was the cake as much as the altruism which achieved N = 21, approximately one third of all EHDRS in the School of Mechanical Engineering.

The first section of questions was designed to establish the nature of the group and their language backgrounds and experience. The students were therefore asked to identify School within ECMS, their gender, age, primary and further languages and prior attainment(s). The students were confused by the language background question and so further oral elucidation as to its purpose was offered (that is, that some parts were designed more particularly for those students who identified as EAL/D or bEAL/D). The range of languages spoken as the first or other language included the Asian languages Bengali, Vietnamese, Mandarin, Malay and Khmer; the Arabic language Persian (itself a politico-cultural statement as the students are all from Iran); plus the European languages Spanish (a Romance language), German (which is obviously Germanic) and Romanian (where the primary influence is Slavic rather than either Romance or Germanic, and where Slavic words exist as synonyms to Romance/Latin lexical items). Eleven out of the twenty-one students, therefore, did not have any form of English as their first or primary language. There are significant inherent grammatical differences between the Asian and Arabic languages and

English: the European languages tend to have closer ties to English grammar as English itself is a mixture of Germanic and Romance languages. This means that over half of the students who attended the workshop have learnt English as additional language or dialect, and this supports the ongoing need for English Language Workshops.

Almost a quarter of the population of the workshop were female (five out of twenty-one). This is a relatively high concentration of women for an Engineering cohort. Throughout the workshop, the women were visible, highly articulate and focused. This was particularly obvious as the males tended to become frustrated with their lack of understanding of grammar, whilst the females tended to be more willing to ask questions and thereby show learning resilience. In terms of approaching learning (other than in terms of patience) there were no other obvious gender differences to suggest that there are gendered EMoCs. The women appeared to be relatively evenly spread across the key Mechanical Engineering sub-disciplines of Combustion, Design, Wave Propagation and Sports Engineering.

Sixteen out of twenty-one students had undertaken other degrees at English-speaking universities prior to their courses at the University of Adelaide; five were attending an English-speaking university for the first time. Three had undertaken a Masters by Coursework at an English-speaking university and two had undertaken a Masters by Research at an English-speaking university. In theory, therefore, most of the students should have had prior English language support for at least two years, so it was interesting that they still felt a need to attend a grammar workshop.

Of the group, sixteen identified as L1 speakers of English, nine as EAL/D and three as background bEAL/D students. These figures are not consistent with the other data and suggest that the EAL/D and bEAL/D EHDRS do not like to be seen as being different from L1 English-speaking EHDRS.

This analysis is, however, completely consistent with group conversations in class, where face-saving is important to many of the students. It echoes an interesting conversation on the PhD OWLS (Older, Wiser Learners) Facebook page, where I asked a question about nomenclature ("*Are Native Speakers of English (NSE)/Non Native Speakers of English (NNSE) acceptable terms for describing groups of language speakers?*") and a large part of the lively and engaged discussion focussed on the international postgraduate students' anger that speakers of standard English (often termed NSEs by the respondents) were frequently perceived as being given preference for English-language teaching jobs over local people, who had been brought up speaking other dialects of English (such as so-called Chinglish or Singlish). Interestingly, the OWLS group were explicit in their condemnation of such decisions as being racist in origin. This argument replicates anecdotal discussions held across campus and reflects a level of anger about discrimination that is seen as stemming from prejudice against the variant forms of English found amongst some of the international HDRS. Academic analysis of this very issue also connects race (often "whiteness") with the control of language or being a "native speaker". Setiawan (2015) argues exactly this point in his PhD thesis, which demonstrates that race and language ability are often conflated.

The OWLS, like Setiawan (2015), felt that "native speaker" is often conflated with "native speaker of standard English", when clearly it is the notion of standardisation that is the issue here. They were not individually distressed by the terms Native Speaker of English (NSE)/ Non-Native Speaker of English (NNSE) (though some did not like them) but felt that racist interpretations and judgements could be attached to the terms, just as Setiawan (2015) found. Specifically, in the discussion about obtaining work, there were a number of posters who felt that the rejection of diverse dialects of English was based on white racial privilege and therefore that such terms should be rejected, although there was agreement that the terms were not easy to replace. As a British (rather than Australian) person by birth, I was surprised by this, as race and language/dialect are not strongly linked in the UK for anyone of my age or younger. Many people who have non-Anglo heritage have been born in, and their families have lived in, the UK through several generations, so it is not normal to make a language assumption based on someone's appearance, but I do understand the point being made. The discussion, however, did confirm that I should use the term Language 1 and Language 2+ speakers of English alongside EAL/D or bEAL/D to avoid giving offence.

When asked further about the correlation between forms of English and work in small, safe, group situations such as CaRST, the EHDRS, too, have been very clear that this issue of standard rather than variant dialects of English is a salient point for them and a source of both frustration and anger. They were very clear that speaking dialectal forms of English (as described earlier) has cost them work and been an emotional burden when writing journal articles and theses. In addition, for this thesis, there is no conflation of bEAL/D or EAL/D and ELF, which is dealt with separately, as currently it is primarily found in more informal situations such as oral discourse or blogging/social media writing, where the primary drive is more informal communication and/or collaboration, rather than the formal, academic language that is the focus of this thesis. Table 5.1 introduces the participants in Spiral 3.

Table 5.1: Language and background composition of the group of participants in Spiral 3, the Product Workshop (N = 21)

University of Adelaide:	21	PhD:	20	MPhil:	1			
ECMS Schools:	Mechanical Engineering	17	Electrical Engineering	1	Petroleum	2	Computer Science	1
Gender:	Male	16	Female	5				
Age:	18-25	5	25-50	1	50+	1		
Language:	L1 English language speakers	12	L2+ English language speakers	9	bEAL/D	3		
Other language(s) spoken:	Bengali (1)	Spanish (1)	Vietnamese (2)	Persian (1)	Mandarin (3)	Malay (1)	Khmer (1)	German, Spanish, Romanian (1)
Prior achievements:	Taken other degrees at English-speaking universities (16)	Taken a Masters by Coursework at an English-speaking university (3)	Taken a Masters by Research at an English-speaking university (2)					

From these initial responses (Table 5.1), it is clear that the EHDRS in the Spiral 3, Product Workshop match with the target audience for the MOG TREE system in that there is a fair representation of the cohort of EHDRS at the University of Adelaide in the Product Workshop and that some of the EHDRS, at least, have clear (probably lived) experience and understanding of the emotional fragility often associated with postgraduate study.

After this first section of personal data collection, the EHDRS were asked about the special characteristics of their approach to learning and the summative responses to the needs analysis (Table 3.2, Appendix 4). Following from the needs analysis, the special characteristics of how EHDRS learn are that they tend to be learners who are:

- Visual-spatial
- Highly conceptual
- Physical-tactile
- Succinct

The EHDRS also agreed that they need help at:

- Word and phrase level
- Genre level
- Greater consistency and clarity of requirements across the School
- Greater understanding of and help for L2+ students, at language and social/cultural levels.

The students feel this would lead to:

- Greater control over word form
- Greater control over word order
- Greater control over genre

By a show of hands and open discussion, there was full agreement that the EHDRS were happy with this assessment of their needs and very aware of how they liked to learn. It was interesting to observe that this conversation was both necessary and quick. Australian students are taught about modes of cognition within the Australian Curriculum and it is a required element of the Personal Learning Plan (SACE 2018, Section 5) that is within South Australian Certificate of Education (taken in Year 12, the terminal year of High School) accreditation, so such discussion is familiar from High School.

I learnt through the Spiral 1 and 2 Workshops that including a brief discussion about metacognition and pedagogy was appreciated by the EHDRS: that they sought the core underpinning theories with which I am working and were happier about engaging with the project as a whole, as well as in part, when they understood and agreed that it was based on relevant theory that matched their experience of learning. For this reason, each section of the testing was introduced with a brief version of the theoretical framework that underpinned that section of the MOG TREE solution. The EHDRS responded with nods of agreement and were happy for me to take the time to frame each section before it was reviewed. They saw this (rightly) as showing them respect as learners, enabling them to think more deeply about how each element of the solution was derived.

It was important that this all articulated with the needs analysis (Table 3.2, Appendix 4) that the original EHDR group had created. This gave all the research strong foundations and increased ready acceptance significantly, as it was designed to do.

Once this had been established, the EHDRS were shown the three approaches on which the tri-partite MOG TREE solution is predicated. This was important, as it enabled them to be part of the detailed discussion of holistic, humanistic learning and to focus their comments and suggestions, whilst honouring their engagement and intelligence, as discussed above.

Each of the three parts of the solution has its own elements. The elements were tested first separately, then in combination. Although a number of the participants in Spiral 3 were also participants in Spirals 1 and 2, not all were, and none had seen the parts working together to build the full MOG TREE solution.

5.2.2 The language tree

This section argues that the language trees will enable EHDRS to manipulate language fluently and effectively by enabling the four key tasks, which stem directly from the needs analysis (Table 3.2, Appendix 4). The language trees are designed to be used for specific instances of nuanced, academic language use by EHDRS. They are therefore used to examine language from this perspective unless the perimeters are changed by a particular class or workshop. The language trees are able to support:

- Language in context
- Social support with peers
- Non-threatening drafting
- A familiar physical-tactile approach to learning.

5.2.3 The corpus and the concordancing tool

This section argues that the concordancing tool will enable EHDRS to manipulate collocations effectively and with far greater accuracy. It answers the needs framed from the needs analysis (Table 3.2, Appendix 4) that concern bEAL/D and EALD EHDRS in particular: collocation errors.

Collocation errors are critical errors, as they repeat frequently across the writing of journal articles and theses. Using an appropriate corpus means that the tool can be used to eradicate many of the errors within the work. This is statistically and emotionally positive. The students were shown the differences between using a standard corpus, where the words are used in their common sense, using a more colloquial vocabulary, and the Mechanical Engineering corpus, which only uses papers drawn from contemporary Mechanical Engineering sources from the School of Mechanical Engineering, at the University of Adelaide.

The EHDRS were shown that they could add to the Mechanical Engineering corpus in order to personalise it for their needs. This is a crucial refinement and makes the corpus infinitely more useful and dependable for this cohort. It also means that the words are pre-selected in a way that dictionaries and thesauri cannot achieve. Whilst these, too, are vital tools, the focus of the corpus and the field from which they can therefore draw their language choices, is targeted and relevant.

The concordancing tool allows the students to review statistical data about language choices. For EHDRS, who work with statistical data regularly, this means that the format of the data is familiar, and so is infinitely more user-friendly. The elements this tool focuses on are:

- Collocation errors
- Statistical data about language choices
- Simple, numerically-driven solution that can be updated and personalised
- A search of language that is 100 percent based on current Engineering publications.

5.2.4 The grammar website

This section argues that the MOG TREE grammar tool, the website, will enable EHDRS to manipulate grammar in order to build fluency and control, as requested through the needs analysis (Table 3.2, Appendix 4). The elements of the solution addressed by http://www.mogtreeapp.com are shown in dot points below.

EHDRS and their supervisors regularly ask me to work on grammar issues. Interestingly, this incorporates far more than linguists' traditional understanding of grammar, so the website also includes syntax, genre and punctuation for effect. The workshop was used to explain how to get the maximum benefit from the website, gave the students time to work with it to locate and explore its intuitive features and then tested their understanding, using a series of increasingly complex tasks.

By making the solution aligned with the EHDRS' cognitive and language needs, the students became interested in how it worked and were willing to engage with it. The website offers:

- A searchable database of expandable, relevant information using both traditional grammar and systemic functional linguistics
- A website which is visually attractive and respectful of learners by design
- A website which separates out lexical, phrasal, sentence and genre level concepts, then re-links them to build fluency
- A dedicated-to-purpose website: all examples come from Mechanical Engineering and so fit the social as well as academic purpose
- It is supported by a workshop, workbooks and individual help, as well as the language trees and the Mechanical Engineering concordance
- It answers the request: "*Teach us what we need to know, not all that you know, when we need to know it*".

5.2.5 Strengths of the solution

The key strengths of the MOG TREE solution all lie in the fact that it is embedded in discipline-specific language needs and the requirements nominated by the EHDRS themselves through the needs analysis (Table 3.2, Appendix 4). The solution was then tested in its parts and as a whole, through the Product Workshop challenges included coding skills and time, ensuring the key information was all included on the website and access issues through the various menus and hyperlinks. Since it was not possible to include a self-test element in the website, this was provided in paper form in the workshop.

5.3 Context

5.3.1 The Workshop

The design of the four hour workshop was meticulous to ensure the balance of learning and teaching would work for the EHDRS. The booklet format for responses to the open-ended and specific questions, along with the booklet for the grammar tests, enabled the incorporation of a version of the self-testing that we had originally hoped to put into the app or website, but which were too complex for the level of coding that was possible in the timeframe. This has the great benefit that an element of "Future work" could be at least partially tested within the workshop and therefore recommended for further examination at the end of the thesis, should we be able to secure a commercial partner, such as one of the academic presses.

Thus, the workshop was designed to be delivered in two stages: effectively "teaching", where the information in the website was taught and explored and "learning", where the students used the booklet to test if they had learned what was on offer.

At the end of each section, the students were referred to the second booklet, which asked them to reflect on how they felt about the experience of using the website: the user interface, the data, the design elements and the match with their identified needs. This booklet invited a mixture of open-ended and Likert scale responses to specific questions prior to and then after using each element of the MOG TREE system and then the system as a whole.

5.3.2 What was tested and why

The booklet for working through the website contains elements of the teaching. As can be deduced from the responses, some of the students left early and the zero scores show where this happened. Whilst they were encouraged to take the booklets with them and return them afterwards, obviously not all students took this option. Although the numbers are small, the zeros are all recorded in the graphs to ensure the authenticity and integrity of the numerical analysis of the outcomes. No individual withdrew permission for their responses to be analysed. Given that this is experimental work, subject to ethics clearance, it was made very clear from the outset that not answering was a perfectly reasonable response and entirely their choice. Of the four students who did leave before the end of the workshop: three had to leave early for supervision meetings and one had a job interview. It was a mark of the level of engagement with the workshop that everyone answered every question for which they were available.

The first set of questions align with the Discovery Workshops in Spiral 1. The slide covering "The Research Ethics Part" had three bullet points, which were read as well as displayed:

- If you would just like to learn the information being offered, please do so
- There is no pressure on you to answer questions or to stay if this does not work for you
- If you choose to leave, please leave your workbook and question booklet behind.

The students were, therefore, very clear that attendance (including on-going attendance) was entirely at their discretion.

All those who attended the workshop were eligible for CaRST hours. Afternoon tea was provided and appreciated. The actual time covered by the workshop was three hours as the level of concentration was high. The workshop consisted of a mixture of teaching via a presentation, the MOGTREE tools and the workbooks.

The knowledge gap under focus was framed and defined for the participants:

- HDR Engineers are highly intelligent, successful learners
- Writing fluent, nuanced prose is hard
- So, this system is designed to work with existing modes of cognition to support and accelerate language learning so that HDR Engineers can learn what they need to know, in familiar ways, on an individualised pathway.

This slide was designed to open up discussion, take pressure off the students and reassure them that the learning was designed to align with their EMoCS.

The survey of information about the participants then took place. The PowerPoint slides contained all the questions as well as the instructions, and a paper version was handed around for the students' own notes. The tri-partite system was briefly outlined in the next slide, along with its aim to accelerate writing and self-editing skills and increase writing accuracy. The first numerical survey was then taken, with the results given in Figure 5.1. The first question asked was: *"How do you normally feel about academic writing?*".

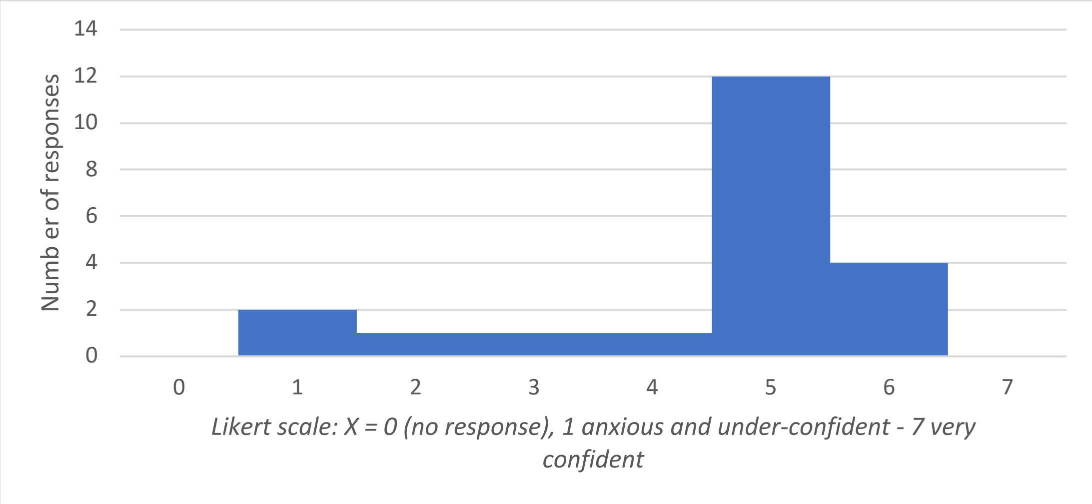


Figure 5.1: ***"How do you normally feel about academic writing"? N = 21. Mean: 4.52***

Five out of twenty-one students felt anxious and under-confident (1-3 on the Likert scale), leaving sixteen feeling broadly confident (4-6 on the Likert scale). None were very confident (7 on the Likert scale). This is in line with how the students present in class. It was also early to establish trust in the group as many of the EHDRS had not worked with me previously, though the privacy of paper-based responses was designed to encourage trust between the individual participants and the researcher. Sauro (2016) advises the use of a chart for analysing small numbers of Likert scale responses, and this is the primary mode used in this chapter for reporting the data.

The mean is given for each of the data sets. Whilst the mean does not carry statistical significance, both because of the small numbers involved and because the data points are derived from a Likert scale, it does reflect the positive trends of the responses.

The next question was designed to elicit engagement levels in order to increase the level of detail in the responses to Figure 5.2: "*How much do you want to improve your academic writing?*".

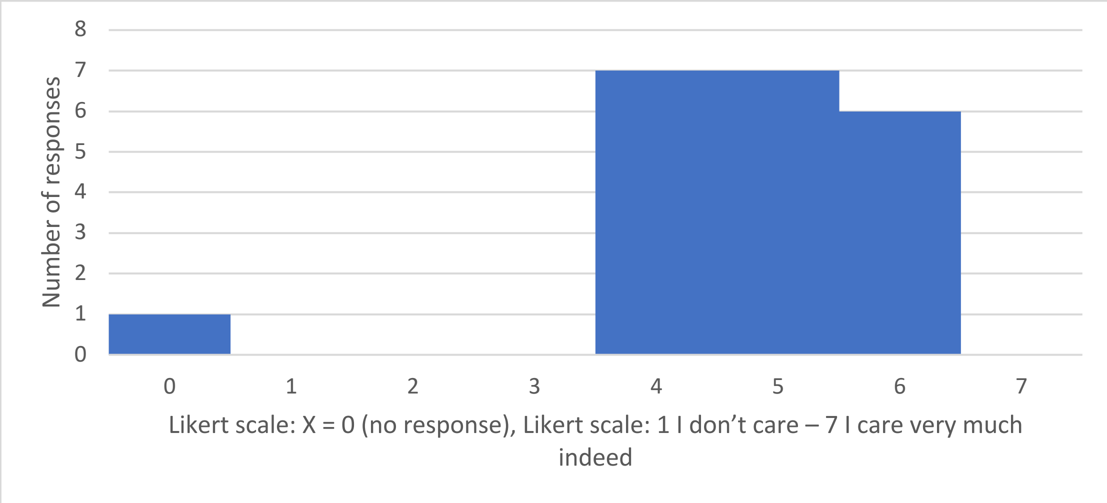


Figure 5.2: "How much do you want to improve your academic writing?" *N = 21. Mean: 4.95*

Here, 100% broad agreement (4-7 on the Likert scale) was given that the students do indeed wish to improve, however much they feel that they are achieving already. This is in line with the feelings elicited in both the needs analysis (Table 3.2, Appendix 4) and the EMoCs, which both recognise students' extant knowledge and their (often substantiated) fear that they do not know enough. It is worth noting that this workshop took place in September, so even those who started their research in second semester would have had time to complete at least one milestone (usually the Common Core of the Structured Program (CCSP) at three months into the program), which meant their academic writing has been formally reviewed at least once and a number of the cohort may have been warned they need to improve their English writing skills in order to move forward to the Major Review at six months (that is, they were given a pass with conditions). This results in their attending my writing classes by instruction if they are in the School of Mechanical Engineering.

5.4 Discussion

5.4.1 Aligning Workshop 1 with the language trees, in the Prototype Spiral

The slide introducing the language trees explains the core theory thus:

- The language tree is designed to help visual-spatial, kinaesthetic learners… or engineers
- You can work either individually or in teams to build up paragraphs and sentences along the trunk and leaves
- Gifted learners tend to love highly conceptual work: the idea is that the physical analogy of the tree supports your skills and gives you confidence because everything can be changed as you edit
- The language tree is also designed to be playful, to support you emotionally to escape from the ravages of imposter syndrome.

The first in the pair of questions about the language trees invites comment before using the language trees themselves, but after introduction to them in context: "*How did you feel when you first saw the language tree?*" (Figure 5.3)

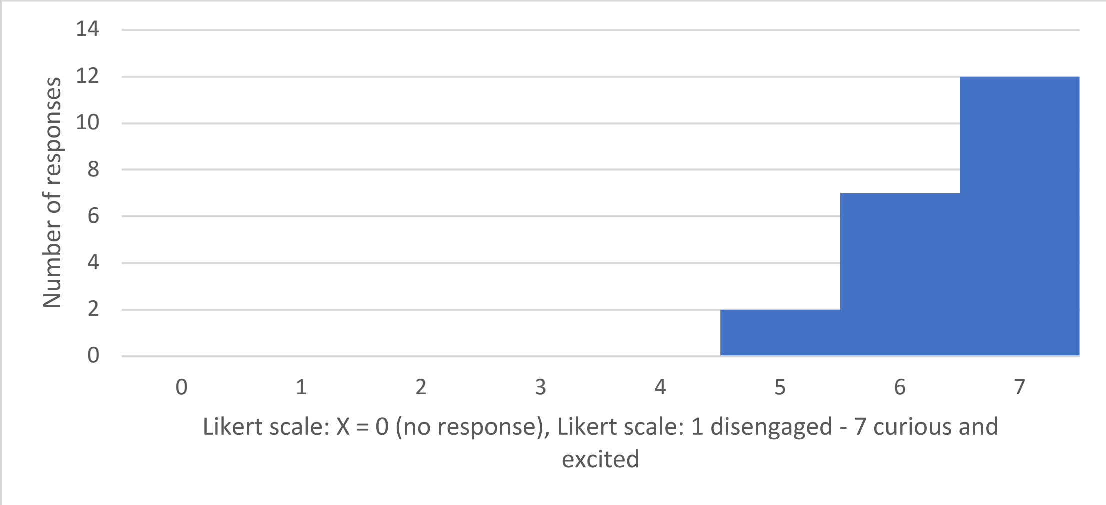


Figure 5.3: "How did you feel when you first saw the language tree?" N = 21. Mean: 6.48

As can be seen in Figure 5.3, the students ranged from positive to very positive (5-7 on the Likert scale) about this experience. Having established this, six volunteers who had not previously used the language trees, or had not used them in their final form at the end of the testing and development process, were invited to come and try using the language trees. The students then created a first sentence for a journal article. This was familiar language for them, although the context could be seen as challenging.

Once the sentences were created, pairs of students were invited to work with the original students on that sentence, with further comment and support offered by the whole group. A range of suggestions were made covering punctuation ("*Should there be a colon?*"), word choice ("*Can you shorten that?*"), article use ("*I think there should be a 'the' there*"), style ("*Is that a question or a statement?*") to collocations ("*Are you sure that's the right word?*" – this was a preposition issue). Even with a relatively short time spent on this activity, there was full engagement with the task.

Afterwards, the students were asked "*How did you feel when you saw the language tree being used?*" (Figure 5.4).

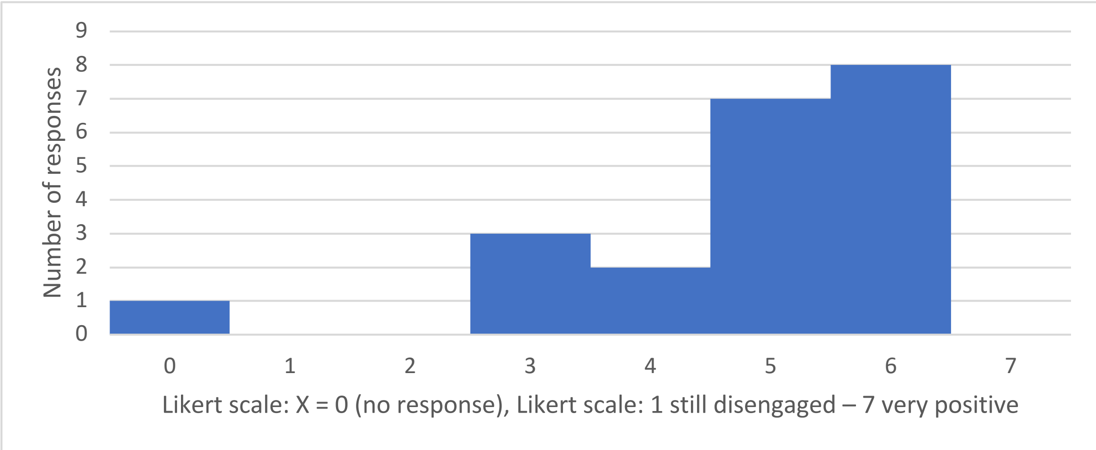


Figure 5.4: "How did you feel when you saw the language tree being used?" N = 21. Mean: 5.5

Support for the use of the language trees was generally strong (4-6 on the Likert scale). Two students qualified their lower scores by saying they would not have been able, emotionally, to work in front of others. The comment in the free text box was: "*I can see that these are very good for social learning. However, I don't do social.*" (Participant 21).

The student who left at this point had a supervision to attend and had explained this earlier, asking to come for as long as possible.

The language tree was very effective at engaging students, was playful (there was much friendly laughter during the drafting process) and enabled more sophisticated writing to be achieved. That said, by definition, it is inherently neutral and cannot offer explanations as to why elements need to be changed and this was acknowledged by the EHDRS.

5.4.2 Aligning Workshop 2 with the Mechanical Engineering corpus, in the Prototype Spiral

A key repeated set of errors come from collocations, and this was the focus of the second part of the solution. By introducing the Mechanical Engineering corpus in this way, it is possible to understand how the corpus and concordancing can be used both separately and together. The slide invited examination of the Mechanical Engineering corpus and concordancing, showing the links across the two, thus:

- Let us look at some of the issues raised by the writing:
- One of them is called collocation
- Collocation = knowing which words tend to go with others
- E.g. – on top….of or on the one hand…on the other hand…
- These can be very confusing, especially if English is not your first language.

The EHDRS were then shown a slide of what concordancing looks like on a (virtual) page, how the colours indicate near fit and how the numbers of words on each line can be adjusted to produce different effects. The next slide was "How concordancers work":

- A concordancer is a tool used with a corpus
- A corpus is a collection of writing located into one place, usually including about 1 million words
- You select how many words you want to see either side of the word you are inputting
- You input the word and then look at what is most likely to come next to the word you have selected.

The group considered a range of published concordancing tools such as an open source website (2018) on Shakespeare. There was agreement (by a show of hands) that Shakespeare is a good writer, so we considered his writing. As the tool is an open source tool, the students could open it on their devices (phone/tablet/laptop) to watch the answer(s) unfold in front of them, so they could see for themselves that although an answer existed, it was not sufficient for contemporary, academic engineering purposes. The slide worked through the process thus:

- Select a word, like “top”, and find it in the list
- The concordancing tool will invite you to choose a play in which to find it
- It should now give examples of its use
- The answers are interesting but do not help with engineering. The first rule we have learnt is that we need a more focused concordance, so that it offers the right form of language in context.

From this, we moved to a corpus in a concordancer that is marketed to and for specific disciplines, for example the Springer concordance (2017). It is perhaps worth noting at this point that since this workshop, Springer have since taken down their concordancing tools. There is some backlash in the academic community about this, as many academics use the concordancing tools on a regular basis (Schreiner 2018). The reason for doing this is unclear to date, with some suggestions being made that the tools will re-emerge from behind a paywall (see Comments on Schreiner 2018).

The slide goes through the same process with Springer as it did for the Shakespeare concordance:

- This is a free, open concordance based around broad disciplines and specific journal titles, through these may be targeted at broad areas of knowledge
- Let us try a typical engineering phrase: “cook stoves”
- Notice how few responses there are?
- Let us try another: “fluid dynamics”
- Now we get hits. Notice the data at the side: we get the disciplines where it appears, the country, the publications and the publisher
- Whilst this is useful, is it targeted enough for a specific type of engineering?

Finally, the students were invited to download AntConc and put the Mechanical Engineering corpus into it. The EHDRS had been invited to download AntConc in advance via their email reminders and the Mechanical Engineering corpus was put onto individual Universal Serial Buses (USBs) issued during the workshop in order to avoid breaking copyright. As the slide explains:

- We now have access to a Mechanical Engineering corpus which goes into a concordancing tool such as AntConc. http://www.laurenceanthony.net/software/antconc/
- Download AntConc (which is free and well-supported online) and add the Mechanical Engineering corpus from the USB
- The Mechanical Engineering corpus contains some 750,000 words of recently published work by our own academics, so it is relevant, quality work
- You can add to the corpus any papers you value to make it even more personalised to your needs.

The next survey asked: "*How did you feel about concordancing when we started?*" (Figure 5.5).

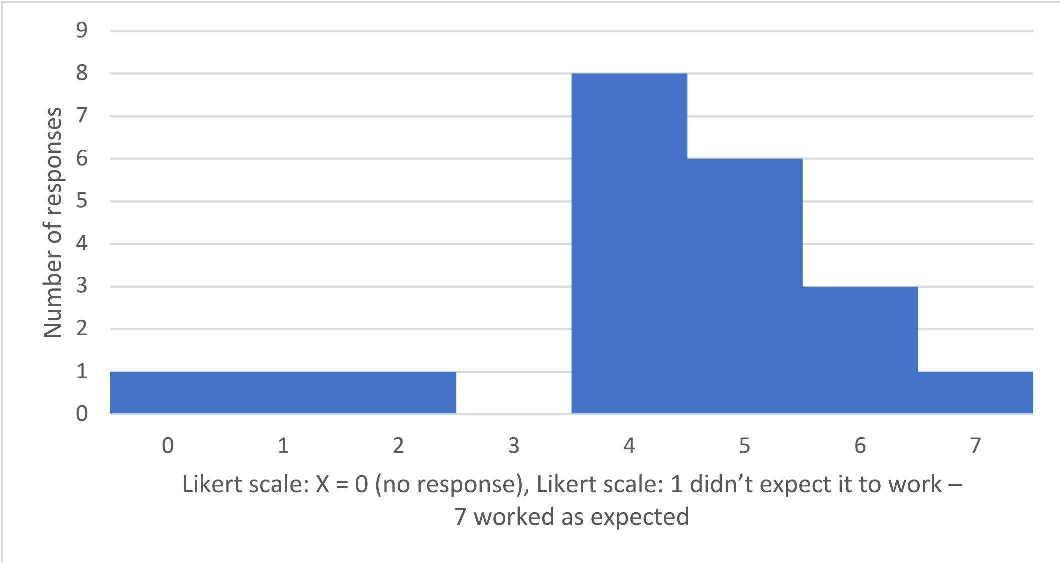


Figure 5.5: ***"How did you feel about concordancing when we started?" N = 21. Mean: 4.5***

As can be seen, there is broad agreement (4-7 on the Likert scale) that they were willing to test this part of the MOG TREE solution. In the first round of testing, there were significant issues with persuading the students to use this tool, so this indicates far greater willingness to engage than I had feared. Once the students had tested the three versions of a Concordancing tool, they were asked: "*How did you feel about using the Mechanical Engineering concordancing tool?*" (Figure 5.6)

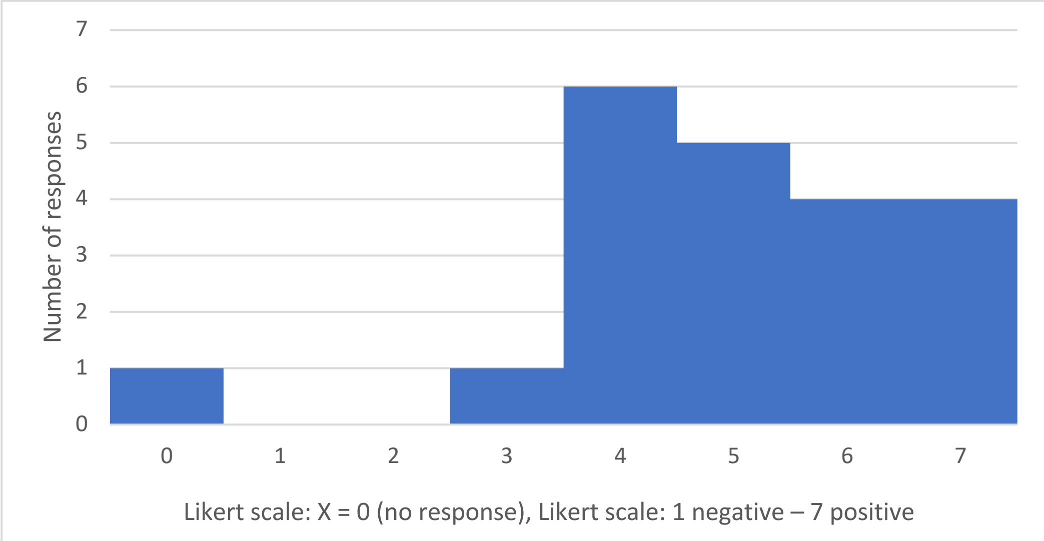


Figure 5.6:* *"How did you feel about using the Mechanical Engineering concordancing tool? N=21, Mean:5.2

As can be seen, the numbers have become far more positive, showing strong broad agreement (4-7 on the Likert scale) that this tool is useful.

As established earlier, the second approach to this kind of language database is to use the corpus itself as a phrasebank. The next two slides explain:

- You can also use the corpus itself, without the concordancing tool
- Look at your journal article. Are you confident with your phrasing?
- Look at several entries in the corpus. Do your sentences fit their pattern?
- Are there typical phrases for starting introductions, for example? If so, do yours match?

- Look at the final sentence of your favourite papers in the corpus
- What kind of sentences are they? Simple, compound or complex?
- What effect do the different types of sentences have?

- Are your own sentences as effective as theirs, or should you play with your sentence to gain maximum effect?

Thus, the EHDRS are shown both uses of the tool (as a phrasebank and as a concordancer), deriving out of their experience of using the language trees and their own writing, to show where this tool will help for particular language issues.

The next pair of questions focus on the use of the corpus itself, without the concordancing tool: "*Have you used published papers to help guide your own writing?*" (Figure 5.7).

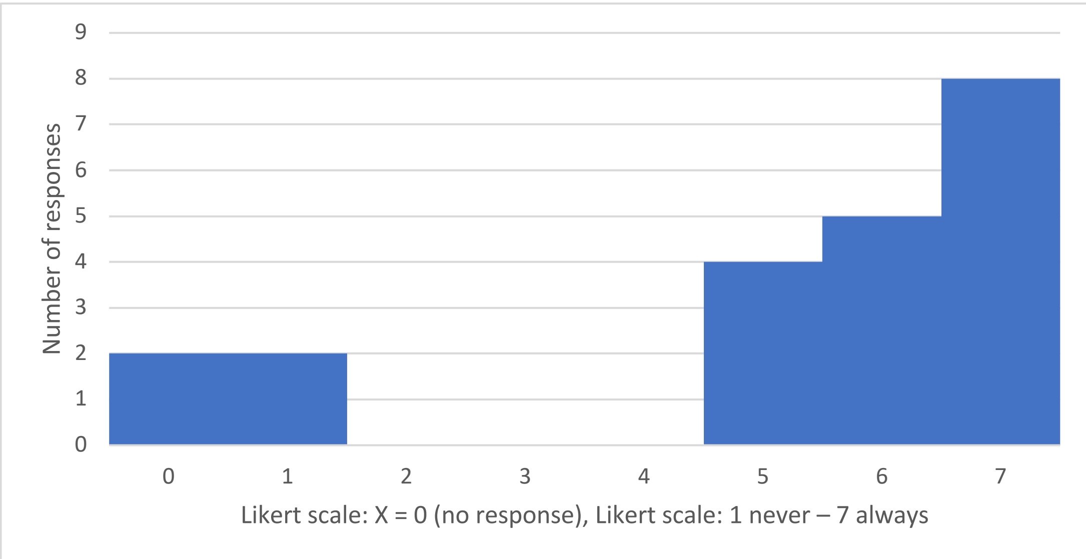


Figure 5.7: "Have you used published papers to help guide your own writing?" N = 21. Mean: 5.94

There is broad agreement (4-7 on the Likert scale) that this is current practice. This outcome suggests that the corpus may have value for the students, as a repository of extant, recent, relevant writing. This leads to the next survey question: "*Might you use a corpus to help you with style and phrasing in the future?*" (Figure 5.8).

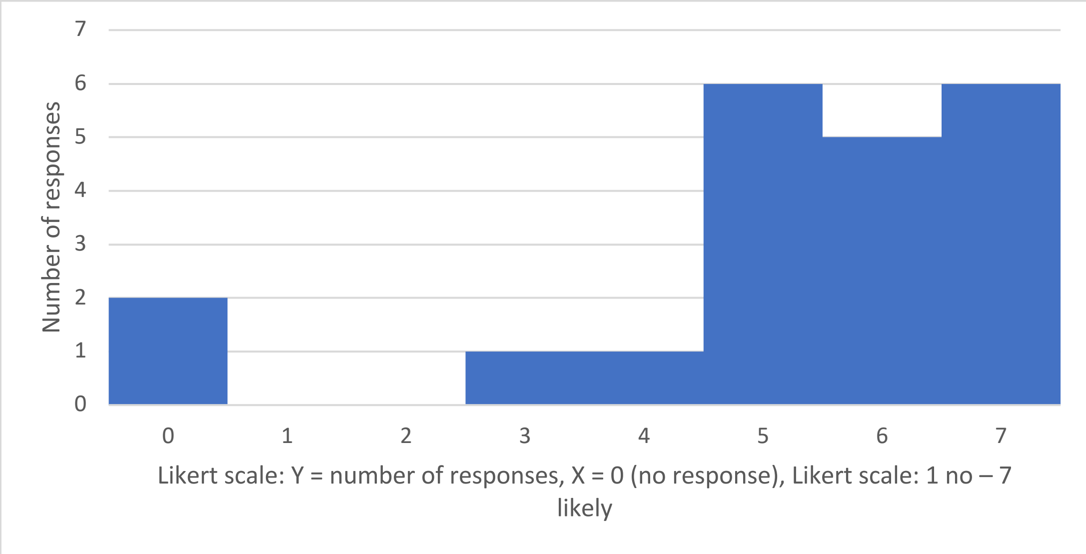


Figure 5.8: "Might you use a corpus to help you with style and phrasing in the future?" N = 21. Mean: 5.32

Whilst there was strong broad agreement (4-7 on the Likert scale) that they would use extant papers as phrasebanks, they were less sure they would use the corpus. Obviously, familiarity with the corpus and updating it to reflect the students' own fields and interests would have an impact on that answer over time.

5.4.3 Aligning Workshop 3 with the grammar website, in the Prototype Spiral

The next section of the workshop focused specifically on grammar. This was and continues to be a focus of requests for support from the EHDR community. The slides introduce the section thus:

- So, you have a new way to play with language and a new resource for searching for collocations, typical phrases, style support and so forth
- But are there still errors in your work?
- If so, a grammar tool designed for engineers may be a good solution

- Today, we are going to look at all it covers and then you can test yourself on your learning using the workbook.
- The tool splits grammar into sections: word, sentence, paragraph, genre and punctuation
- The idea is that you enter at the level at which you are interested when you use the tool itself, but we will work through all the levels today
- Please open up http://www.mogtreeapp.com on your device.

The slides then showed a series of screen shots as we worked through some basic grammar exercises, becoming familiar with the website. We examined the various forms of links within and across the website and where they could be found on the pages. Most importantly of all, they became familiar with the layering and unfolding of the grammar, so they could use the information at the level and point of need, in context, with examples taken from engineering language. Once they were familiar with the tool, the students were invited to use the workbook to check their learning and ensure they had full control of the grammar website and, importantly, that it meets their engineering needs.

Please note that the paragraphs in blue italics replicate the key teaching given in the workshop. EHDRS consistently ask for written as well as oral teaching support in all the writing workshops, as it provides a check and potential later reference point for the learning.

These exercises were given out on paper, rather than electronically. The students were encouraged to write on the whitespace, deliberately made available for them for notes, comments, diagrams and drawings. The first set of exercises checked control of the metalanguage of grammar.

Welcome to the support workbook for the MOG TREES website.

In this booklet are a series of exercises for you to go through to check you have understood how to use the app in detail and that you have learnt more control of grammar by using it. You should also be using the other two parts of the MOG TREE system: the Mechanical Engineering corpus and the Language Trees.

Please feel free to make notes anywhere on the workbook. Your thoughts, ideas, responses and so forth will be used as qualitative data to enrich the analysis of the quantitative data sought during the teaching session. Please hand in your workbook, therefore, at the end of the session. Put your name on the front so I can get it back to you shortly. All names will be removed from the data.

The purpose of this session is to review the usefulness of the app, the system and the workbook: your input is very important to the research. However, if you wish to leave the session at any point, please feel free to do so. Attendance is totally voluntary. Equally if you choose not to answer the survey questions, that is entirely up to you. You are under no pressure whatsoever. Thank you for your attendance and responses.

Alison-Jane Hunter

The students were then invited to check their knowledge of basic grammar.

Exercise 1.

Select the basic definition for the key term.

Check you can define these basic traditional grammar terms.

More than one answer may apply. Choose the best one.

What is a **noun**?

- The name of a place, person or thing
- The name of an object
- A word which gives more information about a place, person or thing

What is a **pronoun**?

- A word which gives more information about a noun
- A word which stands in place of a noun
- A word which precedes a noun

What is a **verb**?

- A doing word
- The word(s) which carries/carry the action of the sentence
- A word which tells the reader when something happened

What is an **adjective**?

- A word which modifies a noun
- An article
- A word which precedes a noun

What is an **adverb**?

- A word which qualifies or modifies the verb
- A word which ends in –ly
- A word which helps to define the tense of the verb

What is a **preposition**?
- A word which locates an idea in place or time
- A word which opens a sentence
- A word which carries the argument of the sentence

What is a **conjunction**?
- The first word of a sentence
- A word which follows a comma
- A word which joins two parts of a sentence

The second set of exercises evaluated connected groups of words, in context:

Exercise 2.

Select the definition for each sentence type and consider its purpose.

Check you are secure with the definition of each sentence type and then think about when it can be used effectively. ***More than one answer may apply. This will help you to nuance your answer. Choose the best one, on balance.***

What is a simple sentence:
- A simple sentence contains a subject and a finite verb
- A simple sentence is short
- A simple sentence is poor style

Why would you use a simple sentence?
- To make a clear statement, such as a thesis statement
- To sum up an argument with a clear answer
- To make your work more accessible

What is a compound sentence:
- A compound sentence contains a theme and a rheme
- A compound sentence contains two independent clauses with a conjunction to show the relationship between the two clauses
- A compound sentence is long

Why would you use a compound sentence?
- To show the progression of your argument
- To make your writing more complicated
- To shorten your writing by linking ideas

What is a complex sentence:
- A complex sentence contains an independent and a dependent clause
- A complex sentence shows a hierarchical relationship between two ideas
- A complex sentence always contains a comma

Why would you use a complex sentence?
- To make your work look more academic
- To show a complex outcome to your argument
- To show how the parts of your argument hang together

The next set of questions considered the use of punctuation as an additional form of meaning, as requested by the EHDRS in Spiral 1:

Why does all this detail matter?

If you can control the parts of speech, you can make your writing more accurate and more effective. For example, if you recognise countable and non-countable nouns, you will have a good chance of using articles (a/an, the) accurately; if you understand sentence types, you can write with more impact; if you know the order of adjectives, you will sound more fluent and more like a native speaker of English.

Once this basic knowledge is secure, you can draw on it easily and move to the more detailed unfolding of the effects of word choices that unfold throughout the website. This will help you to nuance your work and therefore make it stronger in the academic field, it will help you build cohesion through linking sentence types and ideas and it will enable you to write more accurately, avoiding time-consuming, frustrating re-writes.

In the next section, the exercise asks you to review punctuation. Using punctuation effectively makes it much easier for the reader to access your ideas, as they will flow more naturally, and you can use punctuation to point out key elements and links across ideas.

The next twist is that there are two ways of describing grammar: traditional grammar and systemic functional linguistics. I use both types of language, so you can move between the two, selecting the more familiar. Typically, traditional grammar is more useful at word and phrase level and systemic functional grammar is more useful at whole text, or genre level.

Exercise 3

There are four basic punctuation marks.

Use arrows to match the definition to the punctuation mark.

Comma	a mark which shows the end of a sentence
Semi colon	introduces a list or shows a balancing pair of Phrases
Colon	a mark which is used to show the parts of a list or introduce/demarcate a pair of balancing phrases
Full stop	a mark which marks out a separate idea within a sentence

Exercise 4

Using Punctuation to enhance and support meaning.

Use the website (http://www.mogtreeapp.com) to learn about the following punctuation marks and then create five sentences of your own, focusing on punctuation. Play with your sentences to see for yourself how punctuation can change and reinforce meaning.

Comma	**Parentheses or Brackets**	**Semi colons**	**Colons**
Full stops	**Question marks**	**Apostrophes**	

1.
2.
3.
4.
5.

The final group of questions evaluated learning, so the EHDRS tested their learning in context and considered how grammar can be applied to enhance meaning:

Individual Review of Learning.
This next section shows you some worked-through sentences to help you see what each strand of analysis looks like.

Let's work through some sentences together. Select what is useful to you and think about how the different types and levels of information affect your understanding of the sentence and how it fits into the writing as a whole.

Analysis of Sample Sentences:

Simple Sentence	***This***	***work***	***was***	***extended***	***to***	***apply***	***to***	***a***
SFL Descriptors	*Participant (Pointer)*	➔	*Process*	➔	➔	➔	*Circumstance*	➔ *(Pointer)*
TG Descriptors	*Adjective*	*Noun*	*Auxiliary Verb*	*Lexical Verb*	*Introduction of a Verb in the Infinitive*	*Verb in the Infinitive*	*Preposition*	*Indefinite Article*
Simple Sentence	***number***	***of***	***point***	***sources***	***along***	***a***	***line.***	
SFL Descriptors	➔	➔	➔ *(Classifier)*	➔	*Circumstance of place*	➔ *(Pointer)*	➔	
TG Descriptors	*Noun*	*Preposition*	*Adjective*	*Noun*	*Preposition*	*Indefinite Article*	*Noun*	

Compound Sentence	***This***	***work***	***was***	***used***	***as***	***a***	***basis***	***for***
SFL Descriptors	*Participant (Pointer)*	➔	*Process*	➔	*Circumstance (Pointer)*	➔	➔	➔
TG Descriptors	*Adjective*	*Noun*	*Auxiliary Verb*	*Lexical Verb*	*Preposition/ Connective*	*Indefinite Article*	*Noun*	*Preposition*
Compound Sentence	***the***	***current***	***study***	***and***	***was***	***extended***	***to***	***apply***
SFL Descriptors	➔ *(Pointer)*	➔ *(Describer)*	➔	*Connective (introduces the compound clause(s))*	*Process*	➔	➔	➔
TG Descriptors	*Definite Article*	*Adjective*	*Noun*	*Conjunction*	*Auxiliary Verb*	*Lexical Verb*	*Introduction to Verb in the Infinitive*	*Verb in the Infinitive*
Compound Sentence	***to***	***a***	***number***	***of***	***point***	***sources***	***along***	***a***
SFL Descriptors	➔	*Circumstance (Pointer)*	➔	➔	➔ *(Classifier)*	➔	➔	➔ *(Pointer)*
TG Descriptors	*Preposition*	*Indefinite Article*	*Noun*	*Preposition*	*Adjective*	*Noun*	*Preposition*	*Indefinite Article*
Compound	***line***	***as***	***shown***	***in***	***Fig.***	***3.***		

Sentence								
SFL Descriptors	→	*Circumstance*	→	→	→	→		
TG Descriptors	*Key Noun*	*Preposition*	*Past Participle used as an adjective*	*Preposition*	*Noun (note the full stop for the abbreviation)*	*Numeral*		

Complex Sentence	***Extending***	***the***	***work***	***to***	***apply***	***to***	***a***	***number***
SFL Descriptors	*Circumstance*	→ *(Pointer)*	→	→	→	→	→ *(Pointer)*	→
TG Descriptors	*Present Participle*	*Definite Article*	*Noun*	*Introduces Verb in the Infinitive*	*Verb in the Infinitive*	*Preposition*	*Indefinite Article*	*Noun*
Complex Sentence	***of***	***point***	***sources***	***along***	***a***	***line,***	***the***	***original***
SFL Descriptors	→	→ *(Classifier)*	→	→	→ *(Pointer)*	*(comma denotes the end of the dependent clause)*	*Participant (Pointer)*	→ *(Classifier)*
TG Descriptors	*Preposition*	*Adjective*	*Noun*	*Preposition*	*Indefinite Article*	*Noun*	*Definite Article*	*Adjective*
Complex Sentence	***study***	***was***	***used***	***as***	***a***	***basis***	***for***	***the***
SFL Descriptors	→	*Process*	→	*Circumstance*	→ *(Pointer)*	→	→	→ *(Pointer)*
TG Descriptors	*Noun*	*Auxiliary Verb*	*Lexical Verb*	*Preposition*	*Indefinite Article*	*Noun*	*Preposition*	*Definite Article*
Complex Sentence	***current***	***research.***						
SFL Descriptors	→ *(Classifier)*	→						
TG Descriptors	*Adjective*	*Noun*						

Exercise 5 moves to a group, social learning experience:

Exercise 5

Now test yourself for your control of language. In groups, re-order the sentences in the cloze (jumbled word order) exercise below, which create a brief abstract for a journal paper.

Your knowledge of grammar, collocations and punctuation will help you to re-find the original sentences. Use the website to look at the word grammatically and check through the punctuation. Use the Mechanical Engineering Concordancing tool to look at collocations (which words typically go together). Use the MOG language trees to play physically with the sentence. Note that the sentences are in the journal article genre (very written), use academic language (field) and are a mixture of sentence types to heighten interest (social purpose). I've marked out the first and last words of each sentence, plus any internal punctuation, to help you find the basic shape of the sentence. I've worked the first one through as an example. Cross out each word as you go to simplify the process.

1. **Many** fluidised to are create in a jet particles flow bed used flow **system.**

Many	***particles***	***are***	***used***	***to***	***create***	***flow***
Thought process: *This was marked as the first word. It is an adjective, so must be followed by a noun.*	*Here is a noun. I probably need a verb now. There are two available.*	*This must be the auxiliary, and so come first.*	*This is the key noun, so comes second. This is often followed by a verb in the infinitive to create the outcome or use.*	*This introduces the infinitive.*	*This is the stem of the infinitive. It now needs an object (a noun).*	*Here is my noun object. I need a preposition next.*

in	*a*	*jet*	*flow*	*fluidised*	*bed*	*system.*
Here is my preposition. I need an article to introduce a noun phrase next.	*Here is my article. I now need my noun phrase.*	*There are four adjectives and a noun in the noun phrase.*	*Jet is used to modify flow directly, so they must be a pair.*	*Fluidised is used to modify bed directly, so they must be the second pair.*	*This is the type of system being discussed.*	*Here is my key noun to complete the noun phrase. The full stop tells me this is the last word.*

2. **There** A, B through a) this critical of two to are aspects research: of measurement the the they the of as a specific and b) speed flow point A the at points size pass specific particles **and C.**

3. **Following** from it testing, flow be will and argued the of size particles inter-related crucial and this that for are **efficiency.**

4. **Further** specific this direction the the to of also will noted be each at particles **point.**

5. **This** is used to information in determine the why may flow change **speed.**

6. **It** of that changes believed direction the reflect turbulent the in flow a flow bed fluidised is in jet nature **system.**

7. **This** industrial a work has strong **application.**

8. **Once** to speed the the the be the the been and flow size particles of it of have established, should possible enhance of efficacy **mechanism.**

9. **This** the the money this save should for making customer, system more to attractive prospective **purchasers.**

10. **The** to the are date very results **promising.**

11. **This** the the appears early to research confirm of hypothesis **authors.**

12. **Whilst** further new is research this necessary, work a establishes strong between speed link and **size.**

The following page gave the answers, with grammatical reasons:

The correct order for the sentences.
Check your answers below.
1. Many particles are used to create flow in a jet flow fluidised bed system. 2. There are two critical aspects to this research: a) measurement of the size of the particles as they pass through a specific point A and b) the speed of the flow at specific points A, B and C. 3. Following from this testing, it will be argued that the flow and size of particles are inter-related and crucial for efficiency.
4. Further to this, the direction of the particles will also be noted at each specific point. 5. This information is used to determine why the flow may change in speed. 6. It is believed that changes in direction reflect the turbulent nature of the flow in a jet flow fluidised bed system.
7. This work has a strong industrial application. 8. Once the speed of flow and the size of the particles have been established, it should be possible to enhance the efficacy of the mechanism.
9. This should save money for the customer, making the system more attractive to prospective purchasers.
10. The results to date are very promising. 11. This early research appears to confirm the hypothesis of the authors. 12. Whilst further research is necessary, this work establishes a strong new link between speed and size.

Use the layers of supporting grammar in the grids below to help you work out the reasons for any errors you may have made and to lock in your grammatical knowledge securely.

1. Simple	**Many**	**particles**	**are**	**used**	**to**	**create**	**flow**
SFL	Participant (Counter)	→	Process	→	(Circumstance)	→	→
TG	Adjective	Noun	Auxiliary verb (both the auxiliary and the lexical verb show passive, present tense together)	Lexical verb	Preposition	Infinitive verb	Noun
	in	**a**	**jet**	**flow,**	**fluidised**	**bed**	**system**
SFL	Circumstance	(Pointer)	(Noun used as a Describer)	(Describer – hence could be hyphenated)	(Classifier)	(Classifier – hence could be hyphenated)	→
TG	Preposition	Indefinite Article	Noun	Adjective	Adjective	Adjective	Noun

2. Compound	**There**	**are**	**two**	**critical**	**aspects**	**to**	**this**
SFL	Participant	Process	Circumstance	→	→	→	→
TG	Pronoun	Finite verb: present tense	Counter	Describer	Noun	Preposition	Pronoun
	research:	**a) measurement**	**of**	**the**	**size**	**of**	**particles**
SFL	→	Circumstance	→	→ (Pointer)	→	→	→
TG	Noun (Colon used to introduce list)	List indicator: Noun	Preposition	Definite article	Noun	Preposition	Noun
	as	**they**	**pass**	**through**	**a**	**specific**	**point A**
SFL	→	→	→	→	→ (Pointer)	→ (Describer)	→
TG	Conjunction	Pronoun	Finite verb: present tense	Preposition	Indefinite article	Adjective	Noun
	and	**b)**	**the**	**speed**	**of**	**the**	**flow**
SFL	→	Circumstance	→	→	→	→ (Pointer)	→
TG	Conjunction	Marker	Definite article	Noun	Preposition	Definite article	Noun
	at	**specific**	**points**	**A, B**	**and**	**C.**	
SFL	→	→ (Describer)	→	→	→	→	
TG	Preposition	Adjective	Noun	Noun Marker(s)	Connective (always added before the last term in a list)	Noun Marker	

3. Complex	**Following**	**from**	**this**	**testing,**	**it**	**will**	**be**
SFL	Circumstance	→	→ (Pointer)	→	Participant	Process	→
TG	Present participle	Preposition	Adjective	Noun	Pronoun	Auxiliary verb (three parts together show the future, passive voice)	Auxiliary verb
	argued	**that**	**the**	**flow**	**and**	**size**	**of**
SFL	→	Circumstanc	→	→	Connective	Circumstanc	→

		e	*(Pointer)*			*e*	
TG	*Lexical verb*	*Pronoun*	*Definite article*	*Noun*	*Conjunction*	*Noun*	*Preposition*
TG	***particles***	***are***	***inter-related***	***and***	***crucial***	***for***	***efficiency.***
SFL	➔	*Process*	*Circumstance (Describer)*	*Connective*	*Circumstance (Describer)*	➔	➔
TG	*Noun*	*Verb of incomplete predication (present tense)*	*Adjective*	*Conjunction*	*Adjective*	*Preposition*	*Noun*

4. Compound	***Further***	***to***	***this,***	***the***	***direction***	***of***	***the***
SFL	*Circumstance*	➔	➔	*Participant (Pointer)*	➔	➔	➔ *(Pointer)*
TG	*Preposition*	*Preposition*	*Pronoun: Comma used to mark the end of the dependent clause*	*Definite article*	*Noun*	*Preposition*	*Definite article*
	particles	***will***	***also***	***be***	***noted***	***at***	***each***
SFL	➔	*Verb*	➔	➔	➔	*Circumstance*	➔
TG	*Noun*	*Auxiliary verb*	*Adverbial intensifier*	*Auxiliary verb*	*Finite verb (future passive tense)*	*Preposition*	*Counter*
	specific	***point.***					
SFL	➔ *(Classifier)*	➔					
TG	*Adjective*	*Noun*					

5. Simple	***This***	***information***	***is***	***used***	***to***	***determine***	***why***
SFL	*Participant (Pointer)*	➔	*Process*	➔	➔	➔	*Circumstance*
TG	*Adjective*	*Noun*	*Auxiliary verb (with the lexical verb = finite verb)*	*Lexical verb*	*Verb in the infinitive*		*Adverb of reason*
	the	***flow***	***may***	***change***	***in***	***speed.***	
SFL	➔ *(Pointer)*	➔	*Process*	➔	*Circumstance*	➔	
TG	*Definite*	*Noun*	*Auxiliary verb (modal mood)*	*Lexical verb*	*Preposition*	*Noun (full stop to show the end of the sentence)*	

6. Simple	***It***	***is***	***believed***	***that***	***changes***	***in***	***direction***
SFL	*Participant*	*Process*	➔	➔	*Circumstance*	➔	➔
TG	*Pronoun*	*Auxiliary verb*	*Lexical verb*	*Relative Pronoun*	*Noun*	*Preposition*	*Noun*
	reflect	***the***	***turbulent***	***nature***	***of***	***the***	***flow***
SFL	*Process*	*Circumstance (Pointer)*	➔ *(Classifier)*	➔	➔	➔ *(Pointer)*	➔
TG	*Finite verb*	*Definite article*	*Adjective*	*Noun*	*Preposition*	*Definite article*	*Noun*
	in	***a***	***jet***	***flow***	***fluidised***	***bed***	***system.***
SFL	*Circumstance*	➔ *(Pointer)*	➔ *(Describer)*	➔ *(Describer)*	➔ *(Classifier)*	➔ *(Classifier)*	➔
TG	*Preposition*	*Indefinite article*	*Noun as Adjective*	*Adjective (possible hyphen)*	*Adjective*	*Adjective (possible hyphen)*	*Noun*

7. Simple	***This***	***work***	***has***	***a***	***strong***	***industrial***	***application.***
SFL	*Participant*	➔	*Process*	*Circumstance*	➔ *(Intensifier)*	➔ *(Classifier)*	➔

				(Pointer)				
TG	*Possessive adjective*	*Noun*	*Finite verb*	*Indefinite article*	*Adjective*	*Adjective*	*Noun*	

8. Compound	***Once***	***the***	***speed***	***of***	***flow***	***and***	***the***
SFL	*Circumstance*	→ *(Pointer)*	→	→	→	*Connective*	*Circumstance (Pointer)*
TG	*Subordinating conjunction*	*Definite article*	*Noun*	*Preposition*	*Noun*	*Connective*	*Definite article*
	size	***of***	***the***	***particles***	***have***	***been***	***established,***
SFL	→	→	→ *(Pointer)*	→	*Process*	→	→
TG	*Noun*	*Preposition*	*Definite article Po*	*Noun*	*Auxiliary verb All three parts add up to a finite verb*	*Auxiliary verb*	*Lexical verb, passive voice*
	it	***should***	***be***	***possible***	***to***	***enhance***	***the***
SFL	*Participant*	*Process*	→	→	→	→	*Circumstance (Pointer)*
TG	*Pronoun*	*Auxiliary (modal) verb*	*Lexical verb of incomplete predication*	*Adjective*	*Introduction to infinitive verb*	*Main stem of the verb*	*Definite article*
	efficacy	***of***	***the***	***mechanism.***			
SFL	→	→	→ *(Pointer)*	→			
TG	*Noun*	*Preposition*	*Definite article*	*Noun*			

9. Compound	***This***	***should***	***save***	***money***	***for***	***the***	***customer,***
SFL	*Participant*	*Process*	→	*Circumstance*	→	→ *(Pointer)*	→
TG	*Pronoun*	*Auxiliary (modal) verb*	*Lexical verb*	*Noun*	*Preposition*	*Definite article*	*Noun*
	making	***the***	***system***	***more***	***attractive***	***to***	***prospective***
SFL	*Process*	*Circumstance (Pointer)*	→	→	→	→	→ *(Describer)*
TG	*Present participle*	*Definite article*	*Noun*	*Comparative Adverb*	*Noun*	*Preposition*	*Adjective*
	purchasers.						
SFL	→						
TG	*Noun*						

10. Simple	***The***	***results***	***to***	***date***	***are***	***very***	***promising.***
SFL	*Participant (Pointer)*	→	→	→	*Process*	*Circumstance (Intensifier)*	→
TG	*Definite article*	*Noun*	*Preposition*	*Noun*	*Finite verb (to be takes two subjects and acts as an equals sign in the middle of a sentence*	*Adjective*	*Noun*

11. Simple	***This***	***early***	***research***	***appears***	***to***	***confirm***	***the***
SFL	*Participant (Pointer)*	→ *(Describer)*	→	*Process*	→	→	*Circumstance (Pointer)*
TG	*Adjective*	*Adjective*	*Noun*	*Finite verb*	*Introduction to the verb in the infinitive*	*Stem of the infinitive verb*	*Definite article*
	hypothesis	***of***	***the***	***authors.***			
SFL	→	→	→ *(Pointer)*	→			
TG	*Noun*	*Preposition*	*Definite article*	*Noun*			

12. Compound	***While***	***further***	***research***	***is***	***necessary,***	***this***	***work***

SFL	*Circumstance*	➔ *(Describer)*	➔	➔	➔	*Participant (Pointer)*	➔
TG	*Subordinating conjunction*	*Adjective*	*Noun*	*Finite verb of incomplete predication*	*Noun*	*Adjective*	*Noun*
	establishes	***a***	***strong***	***new***	***link***	***between***	***speed***
SFL	*Process*	*Circumstance (Pointer)*	➔ *(Intensifier)*	➔ *(Describer)*	➔	➔	➔
TG	*Finite verb*	*Indefinite article*	*Adjective*	*Adjective*	*Noun*	*Preposition*	*Noun*
	and	***size.***					
SFL	*Connective*	*Circumstance*					
TG	*Conjunction*	*Noun*					

This was the end of the self-testing exercises, though a page was left for free comment. Thus, each set of exercises built upon the last: building from simple, low-level Bloom's taxonomy-based questions of nomenclature, to sophisticated, high-level Bloom's questions of use, which demanded detailed knowledge and analysis (Armstrong 2018).

Given the time constraints of the Product Workshop, we worked through one sample of each element of the long questions together. I also reminded them that this process is what underlies some of my own editing comments on their work. So, when I ask in the comment box, "*Should there be an additional noun here?*" The question stems from my reading of the grammatical structure of the sentence or paragraph.

After this exercise, the students were asked: "*Is the grammar tool clear and easy to use?*" (Figure 5.9).

Figure 5.9: "Is the grammar tool clear and easy to use?" N = 21. Mean: 5.74

There is clearly high broad agreement (4-7 on the Likert scale) within this group that the website has potential for benefitting EHDRS' writing and is easy to use. Where there was any dissent, it came from those undertaking doctorates in Computer Science, who indicated they might have coded the contents differently, had they been asked to do the coding.

The next question asked: "*Is the grammar tool useful?*" (Figure 5.10).

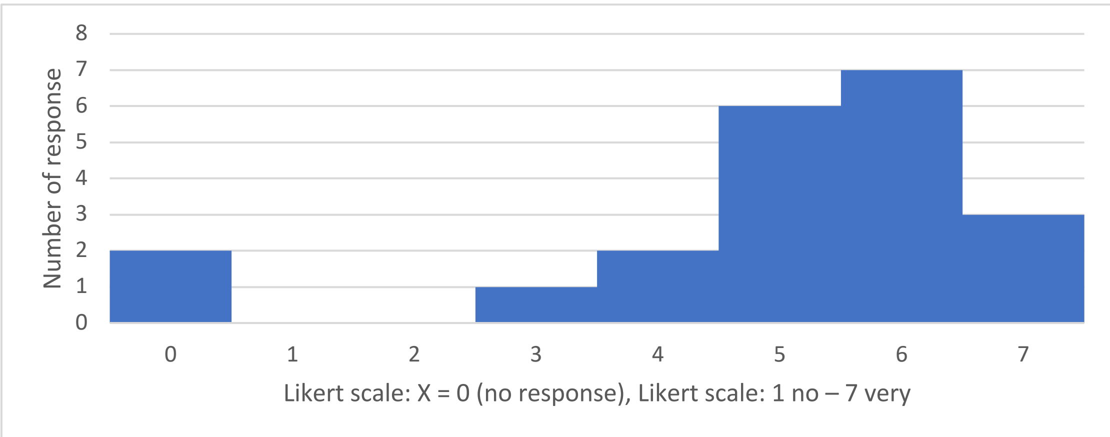


Figure 5.10: "Is the grammar tool useful?" N = 21. Mean: 5.47

This again, showed strong broad agreement (4-7 on the Likert scale) within this group that the tool was useful. The criticism was that it does not contain sufficient examples. This is noted as true. The reason for this was the amount of coding involved in creating the website was significant, so I actually took out a number of examples and the whole of the self-testing section, along with several layers of connections across the site in order to get the website completed and ready for use within a feasible timescale. These were then offered to the students in booklet form during the workshop. Even without these additional elements, the process of developing the contents, designing the architecture and coding the whole took more than a year. When the website is commercialised, this issue will be addressed.

The next question asked about the form of the website: "*Is the grammar tool visually attractive and well-designed?*" (Figure 5.11).

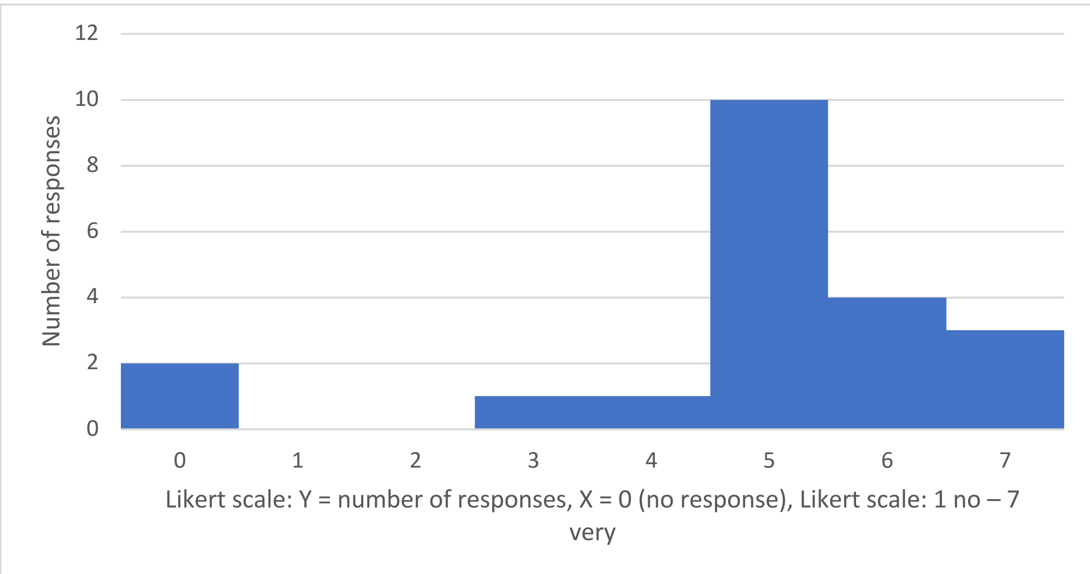


Figure 5.11: "Is the grammar tool visually attractive and well-designed?" N = 21. Mean: 5.37

Again, the responses show a very positive reaction (4-7 on the Likert scale) within this group to the grammar tool, suggesting that it has validity, despite its limitations.

5.5 Results summary

5.5.1 Evaluating the data: analysis of the whole approach

After this set of answers was collected, the final part of the testing considered the MOGTREE solution as a whole, rather than in its constituent parts. The key question, therefore, was: "*The workshop drew the threads of the elements of the system together: would you use all three elements of the MOG TREE system together?*" (Figure 5.12).

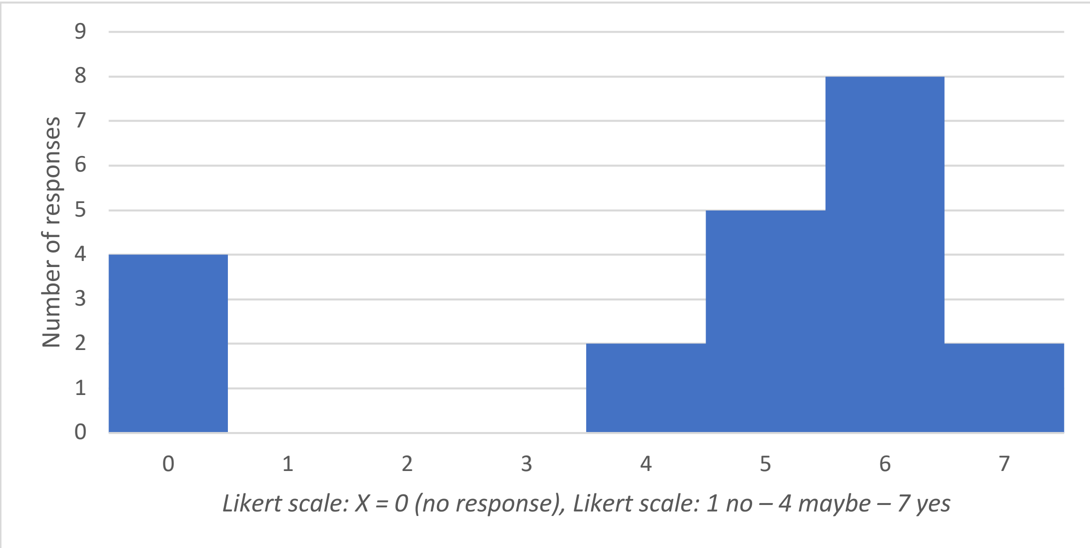


Figure 5.12: "Would you use all three elements of the MOG TREE system together?" N = 21. Mean: 4.59

Despite positive broad agreement within this group, the EHDRS were less sure of this and still sought single, concrete answers to writing questions, as was made explicit in the oral comments, even though the triadic solution was shown as holding together logically and answering different parts of the language conundrum. The students could understand this logic, even though they wished for the simplest possible, unitary solutions: "*How well do you think the three elements work together?*" (Figure 5.13).

Figure 5.13: "How well do you think the three elements work together?" N = 21. Mean: 5.59

This discrepancy between what the EHDRS would like and what they understand is helpful and completely reasonable: after all, language issues are seen as being additional problems, rather than central to their engineering skills, as was revealed clearly in the needs analysis (Table 3.2, Appendix 4). This response linked strongly with issues that occur more generally with language courses in terms of faltering attendance, and with the way I am often asked to edit completed work with incredibly tight deadlines once the work has been rejected by the supervisor, rather than invited to teach the students how to self-edit at the start of a project.

The next question focuses on the affective elements of the MOG TREE system asking: "*How likely do you think it is that the MOG TREE system could help you overcome imposter syndrome or other emotional writing issues such as anxiety, panic or writer's block?*" (Figure 5.14).

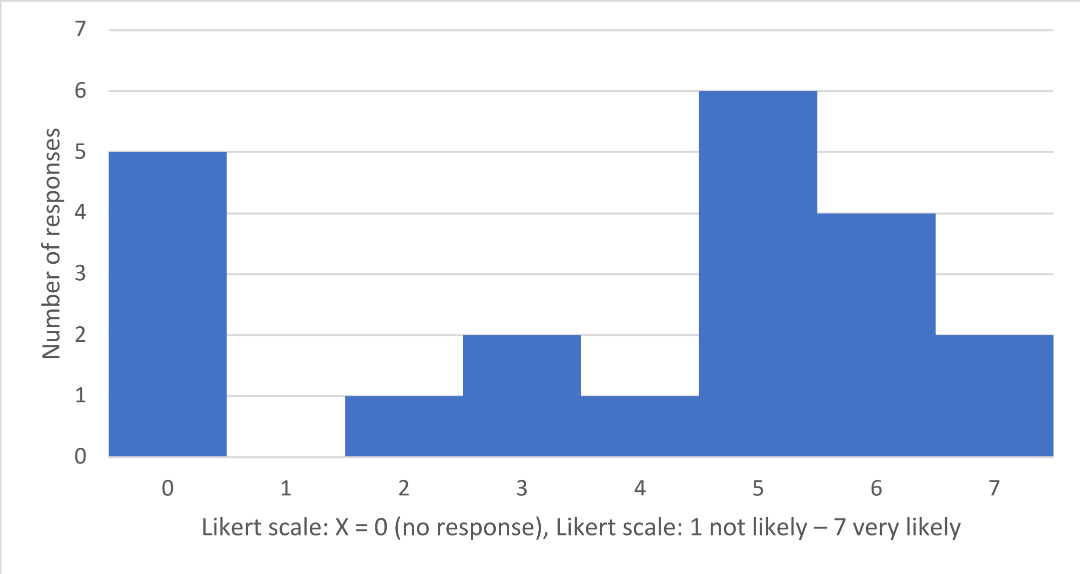


Figure 5.14: ***"How likely do you think it is that the MOG TREE system could help you overcome imposter syndrome or other emotional writing issues such as anxiety, panic or writer's block?" N = 21. Mean: 5***

Again, the group's responses were strong, including more additional comment than elsewhere. Either the students felt that imposter syndrome was an issue and could see the system was built to support emotional engagement in writing, or they were angry that it was implied that they somehow "should" feel this way. This was not, of course, the intention: the purpose was to give them language for their feelings, enabling them to acknowledge these feelings and to find ways to move through them at any point where the feelings become overwhelming. Despite this, one participant commented: "*I understand that other people feel like they have imposter syndrome. But I'm doing a PhD, so clearly I am very clever*." The research suggests that not all HDRS have such self-efficacy, as is shown by the statistics.

5.5.2 Evaluating the data

5.5.2.1. **Strengths**

This section considers the strengths of each element of the tri-partite system and then the system as whole, to summarise the characteristics of each element and the entire system. It is reasonable to suggest that, according to the workshop results, the language trees help to evoke a positive, social learning environment, encouraging self-editing through play and supporting the students to work with language in a non-threatening, familiar learning architecture. The participants enjoyed the working with the language trees and found them helpful, according to their responses.

The EHDRS agreed that the corpus and concordancing tool had value in supporting collocations and generated a genre level phrasebank for their discipline, according to their responses. They were interested in how much help was available through solving repeated errors. They liked the statistical nature of the answers they received through the concordancing tool and agreed that whilst it is most useful for those for whom English is not their first language, it had potential value for all.

The students liked the way the website gives unfolding answers, at the point of need. They liked the engineering examples, which they felt gave relevancy to the answers. They felt the workshop was necessary as they found oral explanations supported the written answers. They liked the privacy of it: they could work with it individually if they were unsure and could then ask more targeted questions if questions still remained, according to their responses.

Furthermore, during the first presentation of the system as a whole, the EHDRS confirmed that they liked the way each element added value to the others, so selections could be made across and within the system. They liked the range of writing elements covered and the way the system is consistently positive and adult. They liked the teamwork elements, as well as the privacy available for each element. They appreciated that its design focus is specific to EHDRS and felt that it addresses issues of imposter syndrome, using a problem-solving approach that is very familiar.

5.5.2.2. **Weaknesses**

This section considers the weaknesses of each part of the system and thus explains why each element is necessary and the whole system is, in fact, greater than its constituent parts.

The students continue to worry about the length of time accurate, nuanced, academic writing can take to prepare. They felt the language trees were more useful for short elements of writing (rather than preparing and creating whole texts) for that reason. Persuading the EHDRS to plan and polish their writing actively continues to be an issue.

The EHDRS continue to worry that they are unclear about what to put in to the concordancing tool in order to get the collocations they need: understanding grammar to recognise articles and prepositions, for example, will support the EHDRS with this issue.

The EHDRS liked the website but felt that there were limited examples, that their supervisors need to be able to use the metalanguage of grammar for it to be fully useful and they worried that it gives reasons, not answers to their particular wording issues.

Overall, whilst they supported the system, the EHDRS continue to worry about writing, time and whether or not they will have access to a language teacher (who is not necessarily their supervisor) at their point of need.

It should be noted that the testing group was small, as it drew only from volunteer EHDRS from one institution.

5.6 Summary

This chapter reports on the workshop that brought together all three parts of the MOG TREE system for the first time and tested them both separately and together in real time, with real EHDRS. The results were strongly positive overall, and the system clearly is seen by the participants as having value.

Whilst the numbers of participants were small, the results are consistent. Further testing will be needed in a wider context to affirm approval statistically.

The caveats about time, confidence and the need for a language teacher continue, but experience with the system should help considerably with these issues.

The workshop tested the three key approaches that underlie the MOGTREE System. First, that the language trees will enable EHDRS to manipulate language socially, playfully and with greater editing confidence. The language trees achieved broad agreement that they would achieve this purpose effectively for most of the EHDRS.

Second, that the concordancing tool will enable EHDRS to manipulate language more effectively, privately and statistically. Again, strong broad agreement was achieved for these elements, suggesting that addressing this set of skills would be useful to the EHDRS. This was particularly true for the target EHDRS with an EAL/D or bEAL/D background. Again, strong broad agreement was achieved for these elements. The grammar website was seen as intuitive to use and helpful. Indeed, the EHDRS wanted more examples, more data and more testing on the site, suggesting a high level of engagement with the system. Figure 5.15 summarises the individual graphs in this chapter.

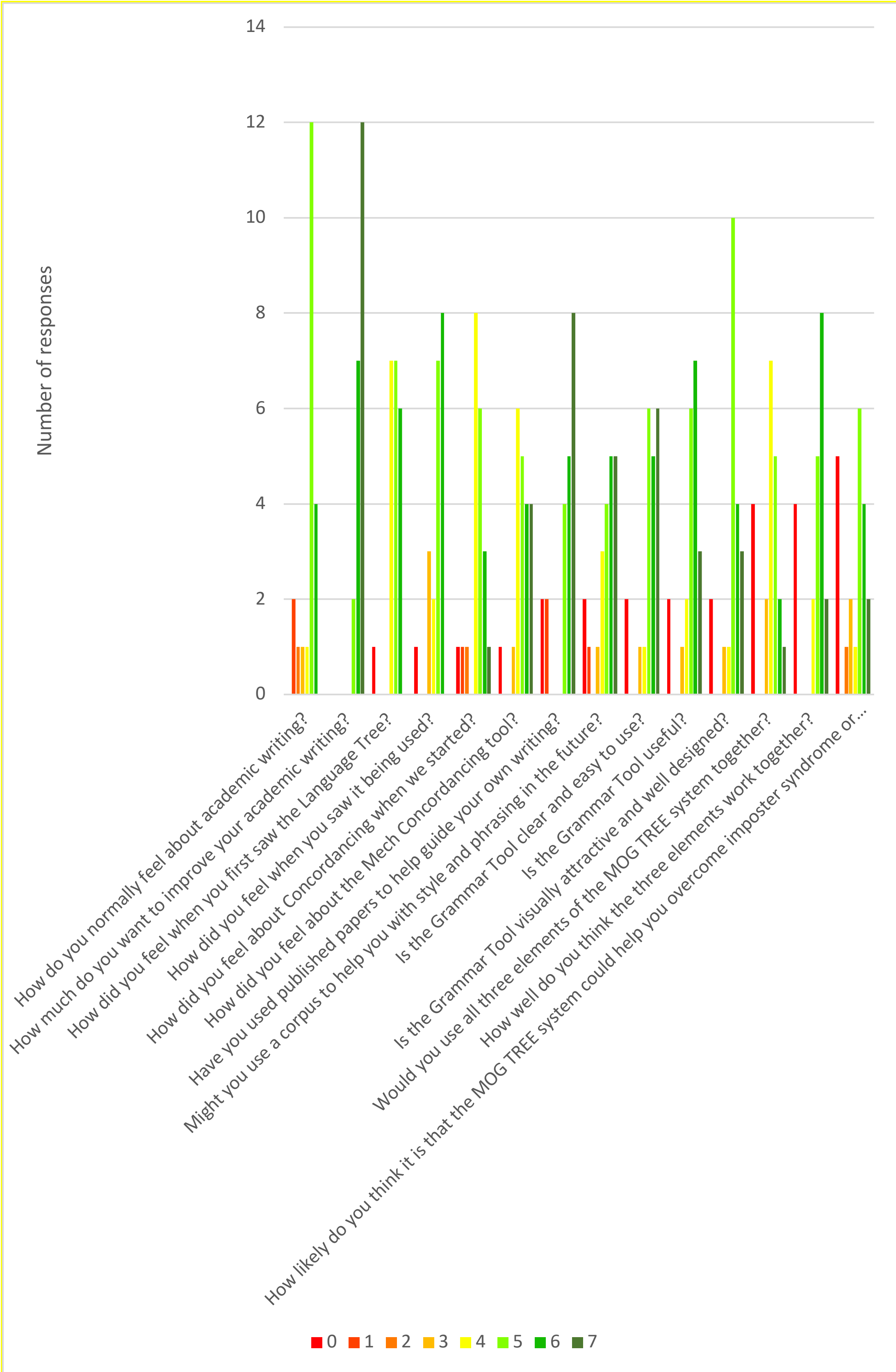


Figure 5.15. Full results for the Spiral 3, Product Workshop

(A summation of the individual graphs in Chapter 5. N=21.
Likert Scale 0-7 where 0=no response and 7=full agreement)

In conclusion, the testing within this group of EHDRS at the University of Adelaide gave positive support for the tri-partite language learning system, both in parts and as a whole, in terms of its relevance to this particular cohort of learners. The next chapter will review the conclusions drawn and link them with Future Work.

Chapter 6.
Thesis conclusions and future work

6.1 Conclusions

This research aimed to find a new solution to the language issues faced by engineering postgraduate research students in order both to support them to achieve accurate, nuanced, academic English at word, phrase, sentence and genre levels and to support them emotionally in order to improve resilience alongside their writing skills. It started in Spiral 1, the Discovery Workshops, with a needs analysis (Table 3.2, Appendix 4) completed by the students themselves, coupled with an analysis of samples of their writing. In order to do this, the researcher recognises the subliminal challenges of writing, placing it in a socio-cultural space that is affirmative, individualised and aligned with the engineers' particular modes of cognition, recognising their exceptional extant and growing discipline-specific skills. In this way, the research places the EHDRS at the centre of the work, taking a fully humanistic approach.

The spiral approach was very beneficial throughout the research, as it enabled strands of knowledge to be revisited regularly and used to inform all future research. The image of the double helix (Figure 1.11) was used to show this clearly, along with the spiral lines through the outer shape to show how each of the three types of workshop also fed forward into one another.

The solution sought was also designed to address the socio-affective and academic needs of the students simultaneously, to enhance their experience of, as well as their knowledge capital of, writing accurate, nuanced, academic English. Acknowledging their high intelligence levels, the research drew on extant knowledge of gifted and talented education, considering the catalysts that prompt accelerated, engaged learning, acknowledging the EHDRS' existing skills and talents. For this reason, EMoCs were analysed, and the approaches taken as a result of this analysis were carefully aligned with the EMoCs. Given that there can be in-built resentment about language learning issues, the research then considered play theory and ensured that a playful, adult approach was taken, enabling social and peer learning, as well as private, individualised learning to be available through the solution.

A Harkness approach was taken to the pedagogical and geographical architecture of the learning space in order to ensure that the entire process was both adult and respectful. It was essential that the students did not feel infantilised and negative about language learning in order to achieve full engagement.

A tri-partite approach was taken to approach all three areas of language learning: each has strengths and each part is stronger for the other parts of the whole system.

In Spiral 2, the Prototype Workshops, the first solution, a language tree was designed, industrial in materials and form and created to align with highly kinaesthetic and visual modes of learning. Through the testing phase, the design became physically stronger and the students made a number of adaptations which made the use of the language trees more individual and flexible, giving the EHDRS control of the learning environment.

The approach underlying this approach to language learning was that it would enable language to be analysed in context; with the social support of peers; enable non-threatening drafting of work and it would offer the familiarity of a physical-tactile approach to learning. The EHDRS felt that the strengths of this approach were that the system offered a social learning environment, supporting positive learning; that its playfulness supported a positive affect for self-editing; and that its highly visual, physical nature felt familiar and therefore comfortable. In terms of its weaknesses, the EHDRS felt it took up too much time to be used for sustained writing; requires help from others which may not always be readily available and that it cannot point out errors, as there is no auto-correct in the language trees. That said, for planning or shorter pieces of writing, it gained broad approval as a writing tool.

Stemming from this, the second solution, the Mechanical Engineering corpus was created. The approach behind this was that it would enable the EHDRS themselves to look up collocations, potentially removing a significant number of errors; that it would offer a simple, numerically driven solution to language choices that can be updated and personalised; and that it would enable a search of language using data-driven learning techniques that is both familiar and based on current, published research papers. After testing, it was clear that the Mechanical Engineering corpus and concordancing tool works best for EAL/D and bEAL/D EHDRS; that it does indeed give helpful statistical probabilities for word choices; that it is extremely helpful for finding statistically valid collocations and that the corpus is helpful for phrasing and structure. The weakness of the Mechanical Engineering corpus and concordancing tool is that the search tool is less valuable for Language 1 (L1) English speakers; it is mechanical, not fluent; it can be slow to conduct and analyse searches; and that the students have to recognise the elements of grammar and genre to generate the right initial questions for both the corpus and the concordancing tool.

In order to address the grammar issues (which, for the EHDRS, included issues of punctuation and syntax), a third solution was generated: the MOG TREE grammar website (http://www.mogtreeapp.com). The hypothesis for the MOG TREE grammar website is that it will offer a searchable database of expandable, relevant information using both traditional grammar and systemic functional linguistics. This dedicated-to-purpose website, contains examples derived from engineering students in order to match its social as well as academic purpose; is visually attractive and respectful of learners by design; supported by a workshop, workbooks and individual help. Alongside the other two parts of the solution; it is a website which separates out lexical, phrasal, sentence and genre level concepts, then re-links them to build fluency and it answers the heart-felt EHDR request: "*Teach us what we need to know, not all that you know, when we need to know it*".

The EHDRS recognised that the MOG TREE website works at word, phrase, sentence and genre level and links across them to build learning; unfolds information through the use of "more" and "back" buttons, greying out pre-viewed data for clarity; uses engineering examples for relevance, offers a quick, private online learning experience and comes with a supporting workshop to build confidence in a social situation. The weaknesses of the MOG TREE website are that, despite teaching background theory and a metalanguage for language learning, the website still requires work on the part of the student; it does not give the answer to language choice questions, it gives the rationale underlying the answer; it has a limited number of examples and attending the workshop and becoming familiar with the website takes time.

In Spiral 3, the Product Workshops, the EHDRS were asked to consider all three parts of the MOG TREE solution, both separately and as a whole. When asked if they would use the tri-partite system together, just over 90% of the participants agreed that they would like to do this. 100% of the EHDRS felt that the system worked together as a whole effectively. Also, 76% of the group felt that the system would support them to overcome imposter syndrome or other kinds of writing anxiety.

Whilst the numbers attending the workshops are small, the results were consistently positive.

This process has been very exciting to observe and encourage. Many of the EHDRS at the University of Adelaide (twenty-one out of some sixty-five) have responded strongly to the offer of help and have strongly shaped the MOG TREE solution. This early, English language research offers originality at design as well as experimental level for the methodological and pedagogical aspects of the work. It is lively and engaging for EHDRS because it is absolutely tailored to their needs as a result of the spiral approach taken and the centrality of their ideas and contributions. Whilst such teaching is complex at both practical and a socio-affective levels, the original MOG TREE solution has demonstrated a robust approach to supporting EHDRS, whether L1, EAL/D or bEAL/D English speakers, positively and pro-actively supporting their English language learning. Expanding the solutions and the testing base can only strengthen this system further and lock in ever greater support for this particular type of learner.

Thus, the summative view of the system (Figure 5.15) was that each element works with the other elements effectively, adding specialist help in a particular area; that the system covers a wide range of relevant language issues; that it takes a positive approach to language learning and that it addresses imposter syndrome as well as language need, is social, encourages teamwork and takes a conceptually familiar, Engineering-aligned, problem-solving approach to language learning.

Overall, the MOG TREE System has been shown to have both a positive effect and a positive affect (emotional impact) on the language learning of EHDRS in the School of Mechanical Engineering at the University of Adelaide.

There are, however, limitations acknowledged throughout the system. First, active participation by a consistent group of EHDRS proved almost impossible to achieve. Even though times were changed, individualised and workshops offered multiple times, the Prototype Workshops had very low, inconsistent attendance. Second, certain EHDRS had a surprisingly strong impact on the outcomes of each spiral. This could have skewed some of the results. As early research in one institution, it is yet to be seen if the results are replicable across a range of institutions with different conditions from this school and site. Finally, there were limitations to the website in particular due to time and coding developmeent issues, which meant that some of what was originally intended to be on the website could only be delivered in a 2D, paper-based form. That said, there appeared to be sufficient detail to each achieved element, or Product, that the EHDRS felt that the testing cycle had validity. Furthermore, there is the fundamental limitation of all qualitative research: that the responses cannot be blind tested and therefore the outcomes cannot be proven empirically or beyond doubt. Despite that, there is strong, evidence-led support for the argument that the MOG TREE system is already useful to and valued by its target users.

6.2 Future work

Future work should involve wider-scale trialling of the tri-partite system across a range of Schools of Mechanical Engineering, regionally, nationally and, later, internationally. This would provide opportunities for further refinement of the system in use and a more extensive program of workshops to support the system. It would also allow continued testing and assessment of the extent to which the system is beneficial for both independent learning and group learning, as well as evaluation of those elements which would benefit from further development.

The creation of a virtual reality language tree and/or extending the range and complexity of the website, http://www.mogtreeapp.com, would enable the incorporation of elements such as more horizontal search modes, enriched examples and thereby accommodate an even more diverse group of learners.

Eventually, the system could be broadened to cover a wide range of disciplines at Tertiary level and then extended to School level to support cross disciplinary language learning at Primary and Secondary levels. At that point, the system would be worth aligning with the full scope of the Australian National Curriculum.

References

Abbott-Jones, L. and Spencer, J., n.d., 'The use of the Harkeness Method of teaching and learning', viewed 01 February 2014, <http://isaacnewtonacademy.org/sites/default/files/INA%20Case%20Study.pdf>

Adelaide Approved, ECMS, 2018, viewed 08 January 2018. <https://ecms.adelaide.edu.au/future-students/undergraduate/>

Adelaide Graduate Centre, 2017a, *Career and Research Skills Training*, viewed 15 November 2017, <https://www.adelaide.edu.au/graduatecentre/handbook/05-candidature/14-carst/>

Adelaide Graduate Centre, 2017b, *Doctor of Philosophy, Program Rules*, viewed 09 November 2017, <https://www.calendar.adelaide.edu.au/aphdr/2017/doctor-philosophy>

Adelaide Graduate Centre, 2017c, *Integrated Bridging Program – Research (IBP-R),* viewed 15 November 2017, <https://www.adelaide.edu.au/graduatecentre/handbook/05-candidature/06-monitoring-academic-progress/05-structured-program/01-core-component/01-integrated-bridging-program-research/>

Adelaide Graduate Centre, 2017d, *Minimum English Proficiency Entry Criteria for Postgraduate Research Students Commencing Candidature in 2017 and 2018*, viewed 15 November 2017, <https://www.adelaide.edu.au/graduatecentre/forms/admission/docs/hdr-english-language-requirements-2017-2018.pdf>

Adelaide Graduate Centre, 2017e, *Preparing Your Thesis for Submission*, viewed 15 November 2017, <https://www.adelaide.edu.au/graduatecentre/forms/thesis/preparing-thesis-submission>

Adelaide Graduate Centre, 2018, *Entry Requirements*, viewed 15 January 2018, <https://www.adelaide.edu.au/graduatecentre/handbook/03-considerations-in-applying/02-entry-requirements/>

Adelaide University, School of Mechanical Engineering, 2018, *Optimising Problem Solving*, viewed multiple times, <https://www.adelaide.edu.au/rsd/smallgroup/examples/ecms/>

Adelaide University, School of Mechanical Engineering, 2018, *Research Opportunities,* viewed 20 January 2018 <https://mecheng.adelaide.edu.au/research/opportunities/>

AdTAT, n.d., *The Adelaide Text Analysis Tool*, viewed 20 January 2016, <https://www.adelaide.edu.au/carst/resources-tools/adtat/>

Anthony, L., 2017, *AntConc*, viewed 30 February 2017 et al. <http://www.laurenceanthony.net/software/antconc>

Areaware, n.d., *Architectural blocks*, viewed 29 January 2016 <https://www.areaware.com/products/blockitecture-deco?variant=21950490372>

Areaware, n.d., *Blockitecture*, viewed 29 January 2017 <https://www.areaware.com/products/blockitecture?variant=48392218884>

Arkoudis, S., & Starfield, S., 2007, "In-course Language Development and Support, International Education Association of Australia", *IEAA Symposium on the English Language Competence of International Students.*

Armstrong, 2018, *Bloom's Taxonomy,* viewed 20 January 2016 <https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>

ASQA , n.d., *VET training*, viewed 08 January 2018, <https://www.asqa.gov.au/about/australias-vet-sector/about-rtos>

Atlantic, Huttner-Koros, A., 2015, 'The Hidden Bias of Science's Universal Language. The vast majority of scientific papers today are published in English. What gets lost when other languages get left out?', 21 August, 2015.

AQF, n.d., *AQF levels*, viewed 30 June 2018 <https://www.aqf.edu.au/aqf-levels>

Australian, Hare, J., 2017, 'Mental Health Issues Soar for PhD Students', 12 April 2017, Higher Education.

Australian Bureau of Statistics, 2013, *Perspectives on Regional Australia: Non-school Qualifications in Regions* <http://www.abs.gov.au/ausstats/abs@.nsf/mf/1380.0.55.011>

Australian Council of Engineering Deans, 2017, "Australian Engineering Education Facts*"* April issue.

Australian Curriculum, 2017, *The Australian Curriculum,* viewed 24 December 2017, <http://www.australiancurriculum.edu.au>

Australian Government, D.E.T., 2017, *International Student Data,* viewed 30 August 2017, <https://internationaleducation.gov.au/research/International-Student-Data/Pages/InternationalStudentData2017.aspx>

Australian Government, D.E.T., 2018, *International Student Data,* viewed 30 August 2018, <https://internationaleducation.gov.au/research/International-Student-Data/Documents/MONTHLY%20SUMMARIES/2018/Jun%202018MonthlyInfographic.pdf>

Australian Learning and Teaching Council, 2008, *Proactive learning,* viewed 20 July 2016, <http://www.olt.gov.au/project-proactive-approach-addressing-uow-2008>

Baker, T., & Nelson, R., 2005, "Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage". *Administrative Science Quarterly*, vol. 50, pp.329–366.

Barrett, G., 2016, *Perfect English Grammar*, Zephyros Press, Berkeley, California.

Barthes, R., 1967, *Death of the Author,* Macat International Ltd, London, U.K.

Bassnett, S., 2002, *Translation Studies*, Routledge, Abingdon, UK.

Bednall, T.C., 2018, *PhD Completion, An Evidence Based Guide for Students and Supervisors*, Conversation, 12 July 2018, <https://theconversation.com/phd-completion-an-evidence-based-guide-for-students-supervisors-and-universities-99650>

Bennet, T., 2013, *Teacher Proof*, Routledge, Abingdon, UK.

Bennett, A., Burton, L.,& Nelson, T., 2010, *Mathematics for Elementary Teachers: a Conceptual Approach,* McGraw Hill Publishing, New York, viewed 31 January 2018, <https://www.chegg.com/homework-help/color-rods-cuisenaire-rods-shown-often-found-elementary-scho-chapter-4.1-problem-9-solution-9780070172999-exc>

Benzie, H.J., 2011, "A Pathway into a Degree Program: Forging Better Links", *Journal of Academic Language & Learning*, vol. 5(2), pp.A107-A117.

Bernat, E., 2008, "Towards a pedagogy of empowerment: The case of 'impostor syndrome' among pre-service non-native speaker teachers", *TESOL*, Elted, Vol 11

Bourke, S., Holbrook, A., Lovat, T. & Farley, P., 2004, "Attrition, Completion and Completion Times of PhD Candidates", paper presented at *AARE*, Melbourne, 2004.

Brabazon, T., 2016, *Play: A Theory of Learning and Change*, Springer, London.

Brabazon, T., 2017, A stroppy professor's guide to poststructuralism, videolog 90 post, 10 December 2017, viewed 20 January 2018 <https://www.youtube.com/watch?v=4cblWJry_Ic>

Bruce, I., 2008, *Academic Writing and Genre: A Systematic Analysis*, Continuum International Publishing Group, London.

Burleson, D., Consulting, 2017, "Learning by Analogy – Oracle", viewed 15 November 2017, <http://www.dba-oracle.com/t_learning_by_analogy.htm>

Cadwell, K., 2017, *Strategies for Classroom Dialogue*, viewed 26 December 2017, <https://katherinecadwell.com>

Caplan, N.A., 2012, *Grammar Choices for Graduate and Professional Writers*, Michegan ELT, Michegan.

Cargill, M., & O'Connor, P., & Li, Y., 2012, "Educating Chinese scientists to write for international journals: Addressing the divide between science and technology education and English language teaching", *English for Specific Purposes*, vol. 31, pp. 60-69.

Cargill, M., & O'Connor, P., 2013, *Writing scientific research articles: Strategy and steps* (2nd ed.). Oxford UK: Wiley-Blackwell. p. 44

Chapman, A., 2017, "Using the Assessment Process to Overcome Imposter Syndrome in Mature Students", *Journal of Further and Higher Education*, vol. 41, iss. 2

Chamberlain, S., 2015, *The Rise of Writing Events gives PhD students the support often lacking in universities*, Conversation, 12 November 2015, <https://theconversation.com/the-rise-of-writing-events-gives-phd-students-the-support-often-lacking-in-universities-50250>

Chambers, C.E., 1964, *Cuisinaire-Gattegno Method of Teaching Mathematics: Course for Teachers*, Cuisinaire Co. of Australia, Blackburn, Vic.

Chen, M., & Flowerdew J., 2018, "Introducing data-driven learning to PhD students for research writing purposes: A territory-wide project in Hong Kong", *English for Specific Purposes* vol. 50 pp. 97–112

Chestnut, H., 1967, *Systems Engineering Methods*, Wiley.

Childers, D., & Bruton, S., 2016, "Should It Be Considered Plagiarism? Student Perceptions of Complex Citation Issues", *Journal of Academic Ethics*, March 2016, vol. 14, iss. 1, pp 1-17.

Choo, H. Y., & Ferree, M. M., 2010, Practicing Intersectionality in Sociological Research: A Critical Analysis of Inclusions, Interactions, and Institutions in the Study of Inequalities. *Sociological Theory*, *28*(2), 129–149.

Cohen, L., Manion, L., & Morrison, K., 2013, *Research Methods in Education*, 7 edn., Routledge, London.

Cohen, W.M., & Levinthal, D.A., 1990, "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, vol. 35, no. 1, special issue: Technology, Organisations, and Innovation (March 1990), pp. 128-152.

Cohen, A.D., & Oxford, R.L., 2001, "Learning Style Survey for Young Learners: Assessing Your Own Learning Styles", viewed 09 November 2017, <http://www.carla.umn.edu/about/profiles/CohenPapers/Young_Style_Survey.doc>

Concoran, J., Gagné, A., & McIntosh, M., 2018, "A Conversation about 'Editing' Plurilingual Scholars' Thesis Writing", *Canadian Journal for Studies in Discourse and Writing/Rédactologie*, vol. 28

Cope, B., & Kalantzis, M., 2008, *Multiliteracies: New Literacies, New Learning* viewed 12 December 2017, <http://newlearningonline.com/files/2009/03/M-litsPaper13Apr08.pdf>

Craig, J.L., Lerner, N., & Myer, P., 2008, "Innovation Across the Curriculum: Three Case Studies in Teaching Science and Engineering Communications", *IEEE Transactions on Professional Communications*, vol. 51, no. 3, pp. 280-301.

Cresswell, J., 2008, *Educational Research Planning, Conducting and Evaluating Quantitative and Qualitative Research,* Pearson International Edition, Upper Saddle River, New Jersey.

Crystal, D., 2007, *How Language Works: How Babies Babble, Words Change Meaning and Languages Live or Die*, Avery, Penguin Group, New York.

Csíkszentmihályi, M., 2008, *Flow: The Psychology of Optimal Experience*, Harper Perennial, New York.

Cummings, J., for the English as a Second Language Council of the Alberta Teachers' Association, 2010, viewed 01 May 2016, Understanding ESL Learners: Distinguishing between Basic Interpersonal Communicative Skills (BICS) and Cognitive Academic Language Proficiency (CALP), *ESL*, vol. 3, iss. 1.

David, L., 2015, "Humanism" in *Learning Theories*, June 12, viewed 31 January 2017, <https://www.learning-theories.com/humanism.html>

de Pillis, E., and de Pillis, L., 2008, Are Engineering Schools Masculine and Authoritarian? The Mission Statements Say Yes, *Journal of Diversity in Higher Education*, Vol.1, No, 1, pp 33-44 DOI: 10.1037/1938-8926.1.1.33

de Saussure, F., 1959, Trans. Baskin, W., *Course in General Linguistics*, Philosophical Library, New York

del Carmen Salazar, M., 2013, 'A Humanizing Pedagogy: Reinventing the Principles and Practice of Education as a Journey toward Liberation', *Review of Research in Education*, vol 37, no. 1, pp. 121-148.

Derewianka, B., 2011, *A New Grammar Companion for Teachers*, NSAW Primary English Teaching Association, Marrickville Metro.

Deutscher, G., 2011, *Through the Language Glass: Why the World Looks Different in Other Languages*, Heinemann, London.

Diamond, A., 2013, Executive functions, *Annual Review of Psychology*, iss.64, 135–168.

Discount Toy Co., 2018*, Fun Factory Cuisinaire Rods,* viewed 31 January 2018, <https://discounttoyco.com.au/category/educational-toys/cuisenaire-rods.html>

Dowling, D., Carew, A., & Hadgraft, R., 2013, *Engineering Your Future* 2nd Ed., Wiley, Milton, Qld.

Dweck, C.S., 2015, 'Growth', *British Journal of Educational Psychology*, vol. 85, no. 2, 14 May 2015, pp.242-245.

Dyrbye, L., Thomas, M., & Shanafelt, T., 2006, 'Systematic Review of Depression, Anxiety, and Other Indicators of Psychological Distress Among U.S. and Canadian Medical Students', *Academic Medicine*, vol. 81, no. 4.

Dyson, B., 2016, 'EAP or Genre-based? A Comparison of Two Curricular Approaches to the Preparation of International Students for University', University of Sydney Papers in *TESOL*, vol., 11, pp.31-66.

Eddy, P.A., 1977, *An Ideas Book for Language Teachers*, viewed 30 January 2018 <https://files.eric.ed.gov/fulltext/ED148171.pdf>

Effective Language Learning, 2018, 'Language difficulty ranking', v viewed 30 January 2018, <https://www.effectivelanguagelearning.com/wp-content/w3tc/pgcache//language-guide/language-difficulty/_index.html_gzip>

Egbert, J., 2017, "Corpus Linguistics and language testing: Navigating unchartered waters", *Language Testing*, Vol 34 (4), pp. 555-564.

Encyclopaedia Britannica, 2018, viewed 27 January 2018, <https://www.britannica.com/science/cognitive-dissonance>

Engineers Australia, 2014, 'A New Era for Engineering Education: Learn What You Need to, When It Suits You', Newsletter July 2014, viewed 30 November 2017, <https://www.engineersaustralia.org.au/portal/news/new-era-engineering-education-learn-what-you-need-when-it-suits-you>

Euromed, 2017, *Learning Readiness*, viewed 04 January 2017, <www.euromedinfo.eu/patient-education-learning-readiness.html/>

Felder, R.M., & Silverman, L.K., 1988, 'Learning and Teaching Styles in Engineering Education', *Engineering Education* 78(7) pp. 674-681.

Fenton-Smith, B., & Humphreys, P., 2015, 'Language Specialists' Views on Academic Language and Learning Support Mechanisms for EAL Postgraduate Coursework Students: the Case for Adjunct Tutorials', *Journal of English for Academic Purposes*, vol. 20, pp. 40-45.

Folauhola, C., Kestell, C., Westphalen, L., & Missingham, D., 2009, 'Engineering Education: Reverse Engineering the Need for an Improved Disciplinary Design', paper presented at *AAEE*, University of Adelaide, December 2009.

Foreign Service Institute, 2018, “Table of Difficulty of Languages to Learn”, viewed 20 January 2018, <http://www.effectivelanguagelearning.com/language-guide/language-difficulty>

Foulger, D., 2004, *Models of the Communication Process, Evolutionary Media*, viewed 27 January 2017, <http://davis.foulger.info/research/unifiedModelOfCommunication.htm>

Flowerdew, J., 1996, ‘Concordancing in language learning’, in M. Pennington (ed.), *The power of CALL*, Houston, Athelstan, pp. 97-113.

Friere, P., 1972, *Pedagogy of the Oppressed*, Harmondsworth, Penguin.

Fries, P.H., & Gregory, M., 1995, *Discourse in Society: Systemic Functional Perspectives: Functional Processes - Meaning and Choice in Language: Studies for Michael Halliday* V. 2 (Advances in Discourse Processes), Kindle Edition, Praegar Australia.

Gagné, F., 2012, ‘Building Gifts into Talents: Brief Overview of the DMGT 2.0’, viewed 27 November 2017, <http://docs.wixstatic.com/ugd/b64a15_d990e509038044d6a59b648bb9e2c472.pdf>

Gagné , F., 2012, ‘Biographical Highlights/APERÇU BIOGRAPHIQUE’, viewed 29 December 2017, <http://gagnefrancoys.wixsite.com/dmgt-mddt>

Gilakjani, A.P., 2012, Visual, aural and kinaesthetic learning styles, their impacts on English language teaching, *Journal of Studies in Education*, Vol 2, No 1, Pp 104-113.

Goldman, S.R., Britt, A.M., Brown, W., Cribb, G., & George, M., 2016, ‘Disciplinary Literacies and Learning to Read for Understanding: a Conceptual Framework for Disciplinary Literacy’, *Educational Psychologist*, vol. 51, iss. 2, pp.219-246.

Goodyear, V.A., Casey, A., & Kirk, D., 2016, ‘Practice Architectures and Sustainable Curriculum Renewal’, *Journal of Curriculum Studies*.

Grammarly, 2017, viewed 01 November 2017, <https://www.grammarly.com>

Gross, M.U.M., 2005, *Exceptionally Gifted Children* (2nd edn), Routledge (Taylor Frances Group), London and New York.

Hadley, G., 2002, ‘An Introduction to Data Driven Learning’, *RELC Journal* Vol 33, Issue 2, pp. 99 – 124

Hair, J.F., Black, W.L., Babin, B.J., Anderson, R.S., & Tatham, R.L., 2010, *Multivariate Data Analysis* (7th edn) Pearson, New Jersey.

Halliday, M., 2012, *Language as Social Semiotic*, viewed 16 November 2017, <http://semioticon.com/semiotix/2012/03/language-as-social-semiotic-in-hallidays-systemic-functional-linguistics>

Harnish, B., 2018, *50 Questions to Evaluate the Quality of your Website,* viewed 04 November 2017, <https://www.searchenginejournal.com/50-questions-to-evaluate-the-quality-of-your-website/>

Harrison, L.M., Clark, G.I., Rock, A.J., Egan, S.J., 2018, 'The impact of information presentation style on belief change: An experimental investigation of a Socratic Method analogue'. *Clinical Psychologist*, Wiley.

Hill, D., 2003, 'Global Neo-Liberalism, the Deformation of Education and Resistance', *Journal for Critical Education Policy Studies*, vol 1, no 1.

Hollis, L.Y., 1965, 'A study to compare the effects of teaching first and second grade mathematics by the Cuisinaire-Gattagno method with a traditional method', *School Science and Mathematics*, vol. 65, iss. 8, pp.683-687.

Holmes, P., & Dervin, F., 2016, 'The Cultural and Intercultural Dimensions of English as a Lingua Franca', *Languages for Intercultural Communication and Education*, Multilingual Matters, Toronto.

Hu, G., 2016, 'Research on Second Language Learner Strategies: Past, Present, and Future', in Y-N. Leung (ed.), *Epoch Making in English Language Teaching and Learning*, Crane Publishing, Taipei, ROC, pp.306-335.

Huddlestone, J., & Pike, J., 2016, *Team and Collective Training Needs Analysis: Defining Requirements and Specifying Training Systems*, CRC Press (Taylor and Frances), London.

Hunter, A.J., Missingham, D.L., Kestell, C., Westphalen, L., 2017, 'Refocusing marking practices to enculturate learning: developing a practice architecture', *AAEE Proceedings* (Paper 53).

Hyland, K., & Bondi, M., 2006, *Academic Discourse Across Disciplines*, Peter Lang AG, Bern.

Hwang, K., 2005, 'The Inferior Science and the Dominant Use of English in Knowledge Production: A Case Study of Korean Science and Technology', *Science Communication*, vol. 26, no. 4.

IELTS, 2014, *IELTS homepage*, viewed 15 November 2017, <https://www.ielts.org/>

Institution of Mechanical Engineers, 2014, 'University of Cambridge test shows Engineers are most autistic profession', viewed 22 January 2015 <http://www.imeche.org/news/news-article/engineers-score-highly-in-autism-quiz-220414-1>

Immordino-Yang, M.H., & Damasio, A., 2011, *We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education*, viewed 01 May 2016, <https://scholar.google.com.au/scholar?hl=en&q=socio+affective+ways+of+learning&btnG=&as_sdt=1%2C5&as_sdtp>

InternChina, 2016, 'The importance of face in Chinese business', viewed 27 April 2017, https://internchina.com/face-（面子-mianzi）-in-chinese-business-culture/

Janssen, D., Tummel, C., Richert, A., & Isenhardt, I., 2016, 'Immersion as a Key Construct for Learning 4.0 in Virtual Environments in Higher Education' *iJAC*, vol. 9, iss. 2.

Jantzen, J., 1998, 'Tutorial on Fuzzy Logic', viewed 24 December 2017, <http://webhome.csc.uvic.ca/~mcheng/460/notes/fuzzy_logic.pdf>

Jiranek, V., 2010, 'Potential Predictors of Timely Completion among Dissertation Research Students at an Australian Faculty of Sciences', *International Journal of Doctoral Studies* Vol 5, 2010 <http://ijds.org/Volume5/IJDSv5p001-013Jiranek273.pdf>

Johns, T., 1994, 'From printout to handout: grammar and vocabulary teaching in the context of data-driven learning'. In T. Odlin (ed) *Approaches to Pedagogic grammar* (pp 292-313) Cambridge, Cambridge University Press.

Johnson, A.C., Wilson, J., Roscoe, R.D., 2017, 'College students' perceptions of writing errors, text quality and author characteristics', *Assessing Writing*, 34, 72-87.

Johnson, B., 2014, 'System Health Management', in Rainey, LB & Tolk, A (eds) (2015) *Modelling and Simulation Support for System of Systems Engineering Applications*, Wiley and Sons, Online.

Jones, A., 2001, *Resistance to English language support. Internationalising the Curriculum.* Macquarie Lighthouse Press, Sydney. Pp 83-92.

K. C., 2017, Hoagies' Gifted Education Page, What is Highly Gifted?', weblog post, n.d., viewed 25 December 2017 <http://www.hoagiesgifted.org/highly_profoundly.htm>

Kincheloe, J.L., 2003, *Teachers as Researchers: Qualitative Inquiry as a Path to Empowerment* (2nd edn). London, Routledge Falmer.

Klinger, R., 2012, "Building Talents on the Foundations of Giftedness", begabungs weblog post, 28 May 2012, viewed 24 May 2015, <https://begabungs.wordpress.com/2012/05/28/building-talents-on-the-foundations-of-giftedness-prof-francoys-gagne/>

Lakoff, G., 1973, *Humanistic Linguistics*, UC Berkeley Previously Published Works, viewed 11 November 2017, <https://escholarship.org/uc/item/1v85307j>

Lakoff, G., & Johnson, M., 1980, *Metaphors We Live By*, University of Chicago Press, London.

Lasser, R., 2013, 'The Engineering Method', in *The Electrical and Computer Design Engineering Handbook*, TUFTS.edu.

Lee, D., & Swales, J., 2006. ‘A corpus-based EAP course for NNS doctoral students: Moving from available specialized corpora to self-compiled corpora’. *English for Specific Purposes*, vol. 25, pp.56-75.

Lentricchia, F., 1980, *After the New Criticism*, University of Chicago Press, Chicago.

Leopold, L., 2011, ‘Teaching Writing Within the Disciplines: a Viable Approach for English for Academic Purposes (EAP) Instructors’, *CATESOL*, vol. 22, iss. 1, pp.167-188.

Lévi-Strauss, C., 1966, *The Savage Mind*, Oxford University Press, Oxford.

Li, J., 2016, ‘Modelling the process of summary writing of Chinese learners of English as a foreign language’, *Irish Educational Studies*, 35:1

Lucas, B., Hanson, J., & Claxton, G., 2014, *Thinking Like An Engineer: Implications for the Education System*, Centre for Real-World Learning.

Lupyan, G., Dale, R., & O’Rourke, D., 2010, 'Language Structure Is Partly Determined by Social Structure (Social & Linguistic Structure)', *PLoS ONE*, vol. 5(1), p.8559.

MacDonald, C., 2012, Understanding Participatory Action Research: A Qualitative Research Methodology Option, Canadian Journal of Action Research Volume 13, Iss. 2, pp 34-50

Mambrol, N., 2016, 'Concept of Bricolage', *Literariness*, weblogpost, 21 March 2016, viewed 16 November 2017, <http://literariness.wordpress.com/2016/03/21/claude-levi-strauss-concept-of-bricolage/>

Mann, L.M.W., 2006, ‘Ways of Experiencing Sustainable Design in Engineering: A Phenomenographic Investigation’, PhD Thesis, University of Queensland, Queensland.

Martin, Y. M., Maclachlan, M., & Karmel, T., 1999, *Postgraduate completion rates.* Department of Education, Training and Youth Affairs, viewed 12 May 2009, <http://www.dest.gov.au/archive/highered/occpaper/01d/01d.pdf>

McCarthy, T., Carew, A., Gardner, A., Goldfinch, T., Henderson, A., & Thomas, G., 2010, ‘A pro-active approach to addressing student learning diversity in engineering mechanics’, viewed 31 March 2017, http://www.olt.gov.au/project-proactive-approach-addressing-uow-2008

McLeod, S., 2018, ‘Cognitive Dissonance’, *Simply Psychology*, viewed 20 June 2018, <https://www.simplypsychology.org/cognitive-dissonance.html>

McTaggart, R., 1989, ‘16 Tenets of Participatory Action research’, viewed 28 January 2016, <www.caledonia.org.uk/par.html>

Montessori, M., 1967, *The Discovery of the Child*, Fides Publishers Inc.

Montessori blocks, 2018, viewed 20 January 2018, <http://www.absorbentminds.co.uk/standard-unit-blocks.html>

Montessori word blocks, 2018, viewed 20 January 2018, <https://www.etsy.com/nz/listing/86225492/the-original-montessori-phonetic-reading>

Moore, T., & Morton, J., 2005, ‘Dimensions of Difference: a Comparison of University Writing and IELTS Writing’, *Journal of English for Academic Purposes* issue 4, pp.43-66.

Morley, J., n.d., *Academic Phrasebank*, The University of Manchester, Online, viewed 24 November 2017, <http://www.phrasebank.manchester.ac.auk/>

Moore, M., 2018, Techradar, blogpost posted 24 April 2018, viewed 25 April 2018, <https://www.techradar.com/au/news/what-is-industry-40-everything-you-need-to-know>

Müller, A., 2015, ‘The differences in error rate and type between IELTS Writing bands and their impact on academic workload’, *Higher Education Research and Development* Vol. 34, issue 6.

Murphy, R., 2004, *English Grammar In Use* (Third ed.). Cambridge, UK: Cambridge University Press.

Nguyen, T., Trimarchi, A., & Williams, J., 2012, ‘Language Diversity and Practice in Higher Education: Can Discipline-Specific Language Instruction Improve Economics Learning Outcomes?’, *Collected Essays on Learning and Teaching*, vol. 5, pp.50-54.

O’Neil, H.F., Lang, J.C., Perez, R.S., Escalante, D., & Fox, F.S., 2014, 'What Is Cognitive Readiness?', in H. O'Neil, R. Perez, & E. Baker, (eds), *Teaching and Measuring Cognitive Readiness*., Springer, Boston MA, pp. 3-23.

Open Source Shakespeare, 2018, <http://www.opensourceshakespear.org.concordance/>

Oxford English Dictionary Online, 2018, <https://en.oxforddictionaries.com/english>

Pain, E., 2017, 'Ph.D. students face significant mental health challenges', *Science*, iss. 04 April.

Paltridge, B., & Starfield, S., 2016, *The Handbook of English for Specific Purposes*, Wiley-Blackwell, West Sussex.

Payne, G., 2014, *Understanding the Training Cycle*, viewed 27 January 2015, <http://www.gillpayne.com/2014/01/guide-understanding-the-training-cycle/>

Pecorari, D., 2015, 'Plagiarism in second language writing: it is time to close the case?' *Journal of Second Language Writing* Vol 30, Pp 94-99.

Peirce, B.N., 1995, 'Social Identity, Investment and Language Learning', *TESOL Quarterly*, Vol. 29, No 1 (Spring 1995), pp. 9-31 Published by: Teachers of English to Speakers of Other Languages, Inc (TESOL).

Peng, H.H., 2009, 'A comparison of the achievement test performance of children who attended Montessori schools and those who attended non-Montessori schools in Taiwan', ProQuest Dissertations Publishing 3394721, pp.108-110.

Pfeiffer, S., & Stocking, V., 2000, 'Vulnerabilities of Academically Gifted Students', *Journal of Applied School Psychology*, vol. 16, no. 1-2, pp. 83-93.

Piaget, J., 1976, *Piaget and his School* (pp. 11-23). Springer, Berlin Heidelberg.

Pinker, S., 2014, *The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century*, Penguin, New York.

Pohl, K., 2010, *Requirements Engineering: Fundamentals, Principles and Techniques,* Springer Publishing Inc.

Pyryt, M., 2008, 'The Dabrowskian Lens: Implications for Understanding Gifted Individuals', in S. Mendaglio, (ed.), *Dabrowski's Theory of Positive Disintegration*, Great Potential Press, Scottsdale, AZ.

Reinharz, S., 1992, *Feminist methods in social research,* OUP, Oxford.

Retallick, M., 2012, "How to extract the facts with a Web Design Client Questionnaire" weblog post 16 March 2012, viewed 30 January 2016, <https://business.tutsplus.com/articles/how-to-extract-the-facts-with-a-web-design-client-questionnaire--fsw-1830>

Richardson, M., Abraham, C., & Bond, R., 2012, 'Psychological Correlates of University Students' Academic Performance: A Systematic Review and Meta-analysis', *Psychological Bulletin*, 138(2)

Riddle, T., 2015, *The Greatest Gatsby: A Visual Book of Grammar*, Penguin Group, Melbourne.

Robinson, J., 1998, 'Engineering Thinking and Rhetoric', *Journal of Engineering Education*, vol 87, issue 3, July 1998, pp.227-229.

Rogoff, I., 1998, ‘Studying Visual Culture’, in N. Mirzoeff (ed.), *The Visual Culture Reader*, Routledge, London, pp.24-37.

Rose, G., 2013, ‘Time required for developing expertise and the ten year rule’, blogpost 05 March 2013, viewed 09 January 2018, <http://www.mytpi.com/articles/juniors/time_required_for_developing_expertise_and_the_10_year_rule>

SACE, 2018, ‘PLP’, viewed 12 September 2016, <https://www.sace.sa.edu.au/web/personal-learning-plan>

Sadeghi, Z., 2010, The Importance of Collocation in Vocabulary Teaching and Learning, Translation Journal, Vol 14, No. 2, April, accessed 31 January 2017 <https://translationjournal.net/journal/52collocation.htm>

SAGE Publishing, 2017, ‘Manuscript Submission Guidelines’, SAGE Publishing, viewed 31 May 2018, <https://au.sagepub.com/en-gb/oce/manuscript-submission-guidelines>

SAGE Publishing, 2018, ‘Language Services’, viewed 30 January 2018 <http://languageservices.sagepub.com/en/services/editing/>

Sahr, S., 2013, “Cuisinaire Rod Activities for Language Development”, *TESOL Connections,* viewed 31 January 2018, <http://newsmanager.commpartners.com/tesolc/issues/2013-10-01/index.html>

Salkind, N., 2012, *100 Questions (and Answers) About Research Methods*, SAGE Publications, London

SATAC, 2018, ‘The Special Tertiary Admissions Tests (STAT)’, viewed 19 June 2018 <http://www.satac.edu.au/stat>

Sauro, J., 2016, ‘Can you take the mean of Ordinal data?’, viewed 18 July 2018, <https://measuringu.com/mean-ordinal/

Schleppegrell, M., 2013, ‘The role of metalanguage in supporting academic language development’, *Language Learning,* vol. 63, iss. S1 Wiley

Schneps, M., 2014, ‘The advantages of Dyslexia’, viewed 18 July 2018, <https://www.scientificamerican.com/article/the-advantages-of-dyslexia/>

School of Mechanical Engineering, 2018, ‘2018 Research Opportunities’, viewed 1 April 2018 <https://mecheng.adelaide.edu.au/research/opportunities/>

Schreiner, S., 2018, ‘What happened to Springer Exemplar?’, viewed 14 September 2018, <https://www.researchgate.net/post/What_happened_to_Springer_Exemplar>

Setiawan, A., 2015, ‘Attitudes towards Indonesian Teachers of English and Implications for their Professional Identity’ PhD Thesis University of Adelaide

Shah, S., and Missingham, D., 2018, unpublished fragment, personal communication.

Shannon, C.E., & Weaver, W., 2011, ‘Shannon-Weaver model’, viewed 24 February 2015, <https://www.communicationtheory.org/wp-content/uploads/2011/06/shannon_weaver_model.jpg>

Shapiro, S., 2001, ‘What is the Harkness Method?’, viewed 24 February 2015, <https://katherinecadwell.com/what-is-the-harkness-method/>

Sharma, G., 2013, *Models of Communication*, viewed 27 January 2017, <https://www.slideshare.net/geniusgautams/models-of-communication-23831945>

Shemshadi, A., 2016, ‘The Internet of Things’, PhD thesis, The University of Adelaide

Shing, S.R., & Tam, S.S., 2011, 'EAP Needs Analysis in Higher Education: Significance and Future Direction', *English for Specific Purposes World*, vol. 11, no. 33.

Sicart, M., 2014, *Play matters*. Cambridge: MIT Press.

Simons, H., 1996, *The paradox of case study*. Cambridge Journal of Education, 26 (2), 225-40.

Sinclair, J., 2017, *COBUILD English Grammar,* HarperCollins, Glasgow, U.K.

Sloboda, A., Davidson, J., Howe, M., & Moore, D., 1996, ‘The Role Of Practice in the Development of Performing Musicians’, *The British Journal of Psychology*, vol. 87, iss 2, pp. 287-309.

Smith, M., K., 1994, *Local Education. Community, conversation, action*. Buckingham: Open University Press.

Smolicz, J.J., & Harris, M.R., 1977, ‘Ethnic Languages in Australia’, *Linguistics*, vol.198, pp.89-108.

Springer, 2017, ‘Springer launches SpringerExemplar.com’, viewed 18 September 2016, <http://www.springer.com/societies+%26+publishing+partners/springer+in+the+news?SGWID=0-161903-2-772409-0>

Springer, 2017, ‘Springer Exemplar’, viewed across 2016 and 2017, <http://springerexemplar.com>

Statistics South Africa, 2014, *Statistical Release P0302*, viewed 19 January 2018, <https://www.statssa.gov.za/publications/P0302/P03022014.pdf>

Stinchfield, B.T., Nelson, E., & Wood, M.S., 2012, 'Learning from Lévi-Strauss' Legacy: Art, Craft, Engineering, Bricolage and Brokerage in Entrepreneurship', *Entrepreneurship Theory and Practice,* vol. 37, iss. 4.

Sumsion, J., Barnes, S., Cheeseman, S., Harrison, L., Kennedy, A., & Stonehouse, A., 2009, 'Insider Perspectives on Developing Belonging, Being and Becoming: the Early Years Learning Framework for Australia', *Australasian Journal of Early Childhood*, vol. 32, iss. 4, pp. 4-13.

Swales, J., 1990, *Genre Analysis. English in Academic and Research Settings*, Cambridge University Press, Cambridge.

Swan, M., 2012, ELF and EFL: are they really differenct? *Journal English as a Lingua Franca* Pp 379-389.

Swinburne University, 2016, 'VAK', viewed 01 May 2016, <www.swinburne.edu.au/stuserv/workshops/...files/1VAK%20assessment.pdf >

TEQSA, 2015, 'Australian Qualifications Framework', viewed 01 May 2017 <https://www.teqsa.gov.au/australian-qualifications-framework>

The British Council, 2017, 'Understand your IELTS Scores: The IELTS 9-Band Scale, The British Council', viewed 16 November 2017, <https://takeielts.britishcouncil.org/find-out-about-results/understand-your-ielts-scores>

Thompson, P., & Diani, G., 2015, 'English for Academic Purposes: Approaches and Implications', viewed 09 November 2017, Cambridge Scholars Publishing, Online. <http://www.cambridgescholars.com/download/sample/62457>

Timor, T., 2018, Perceptions of academic literacy courses in a postgraduate programme in Israel, *Journal of Accademic Language and Learning,* Vol 12, No 2, Pp 18-38.

UK Curriculum, 2014, viewed 24 December 2016, <https://www.gov.uk/government/collections/national-curriculum#history>

Universities Australia, 2017, 'Key Facts and Data', viewed 01 April 2018, <www.universitiesaustralia.edu.au/australias-universities/key-facts-and-data#>

University of Melbourne, 2017, 'Admissions and Applications', viewed 15 November 2017, <https://futurestudents.unimelb.edu.au/admissions/entry-requirements/language-requirements/graduate-toefl-ielts - mse>

Velautham, V., & Picard, M.Y., 2009, 'Collaborating equals: engaging faculties through teaching-led research', *Journal of Academic Language & Learning* vol. 3, no. 2, A130-A141.

Victoria State Government, Education and Training, n.d., Literacy Teaching Toolkit. Teaching-learning cycle: reading and writing connections, viewed 26 July 2017, <https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/english/literacy/readingviewing/Pages/teachingpraccycle.aspx>

vitae, 2017, 'The Vitae Researcher Development Framework', viewed 26 December 2017, <https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework/developing-the-vitae-researcher-development-framework>

Vygotsky, L., 1978, *Mind in Society: Development of Higher Psychological Processes*, Cambridge, Harvard University Press.

Westwell, M., 2013, 'When the educational neuroscience meets the Australian Curriculum: A strategic approach to teaching and learning', viewed 01 July 2016, <https://research.acer.edu.au/cgi/viewcontent.cgi?article=1171&context=research_conference>

Widdowson, H.G., 2013, ELF and EFL: What's the difference? Journal of English as a Lingua Franca 2 (1) Pp 187-193.

Wikipedia, 2015, 'List of typefaces', viewed 01 January 2015, <https://en.wikipedia.org/wiki/List_of_typefaces>

Wiley, 2017, 'Manuscript Preparation Guidelines', viewed 14 November 2017, <https://authorservices.wiley.com/author-resources/Journal-Authors/Prepare/manuscript-preparation-guidelines.html>

Williams, G.J., 2014, 'Case Study', viewed 20 June 2017, <http://isaacnewtonacademy.org/sites/default/files/INA%20Case%20Study.pdf>

Winsor, D.A., 1990, 'Joining the Engineering Community: How Do Novices Learn to Write Like Engineers?', *Technical Communication*, vol 37, no 2, p171-172 May 1990

Yılmaz, E., & Soruç, A., 2015, 'The Use of Concordance for Teaching Vocabulary: A Data-Driven Learning Approach', *Procedia-Social and Behavioral Science*, 191, Pp. 2626-2630, Elsevier.

Referencing Guide:

University of Woolongong, (n.d.), *UOW Harvard Referencing Style,* <https://www.library.uow.edu.au/content/groups/public/@web/@lib/documents/doc/uow220276.pdf>

Appendix 1: AQF Level 10 Criteria

AQF level 10 criteria

Summary

Graduates at this level will have systematic and critical understanding of a complex field of learning and specialised research skills for the advancement of learning and/or for professional practice.

Knowledge

Graduates at this level will have systemic and critical understanding of a substantial and complex body of knowledge at the frontier of a discipline or area of professional practice.

Skills

Graduates at this level will have expert, specialised cognitive, technical and research skills in a discipline area to independently and systematically:

- engage in critical reflection, synthesis and evaluation
- develop, adapt and implement research methodologies to extend and redefine existing knowledge or professional practice
- disseminate and promote new insights to peers and the community
- generate original knowledge and understanding to make a substantial contribution to a discipline or area of professional practice

Application of knowledge and skills

Graduates at this level will apply knowledge and skills to demonstrate autonomy, authoritative judgement, adaptability and responsibility as an expert and leading practitioner or scholar.

https://www.aqf.edu.au/aqf-levels

Appendix 2: Table of difficulty of languages to learn

Category I: 23-24 weeks (575-600 hours) Languages closely related to English	
Afrikaans Danish Dutch French Italian	Norwegian Portuguese Romanian Spanish Swedish
Category II: 30 weeks (750 hours) Languages similar to English	
German	
Category III: 36 weeks (900 hours) Languages with linguistic and/or cultural differences from English	
Indonesian Malaysian	Swahili
Category IV: 44 weeks (1100 hours) Languages with significant linguistic and/or cultural differences from English	
Albanian Amharic Armenian Azerbaijani Bengali Bosnian Bulgarian Burmese Croatian Czech *Estonian *Finnish *Georgian Greek Hebrew Hindi *Hungarian Icelandic Khmer Lao Latvian	Lithuanian Macedonian *Mongolian Nepali Pashto Persian (Dari, Farsi, Tajik) Polish Russian Serbian Sinhala Slovak Slovenian Tagalog *Thai Turkish Ukrainian Urdu Uzbek *Vietnamese Xhosa Zulu
Category V: 88 weeks (2200 hours) Languages which are exceptionally difficult for native English speakers	
Arabic Cantonese (Chinese) Mandarin (Chinese)	*Japanese Korean

* Languages preceded by asterisks are usually more difficult for native English speakers to learn than other languages in the same category.

http://www.effectivelanguagelearning.com/language-guide/language-difficulty

Appendix 3: HREC Consent

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY

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CRICOS Provider Number 00123M

Applicant: Dr M Picard

School: School of Education

Project Title: Accelerating Higher Degree by Research (HDR) Mechanical Engineers' academic writing skills: an analysis of the development and outcomes of a novel visual-spatial, physical-tactile, integrated English language learning intervention, drawing on engineering modes of cognition

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The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)

ETHICS APPROVAL No: H-2015-200 **App. No.: 0000020837**

APPROVED for the period: 09 Sep 2015 to 30 Sep 2018

Thank you for your responses dated 26.8.15, 3.9.15 and 4.9.15 to the matters raised.

This study is to be conducted by Alison-Jane Hunter, Masters student.

PROFESSOR RACHEL A. ANKENY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

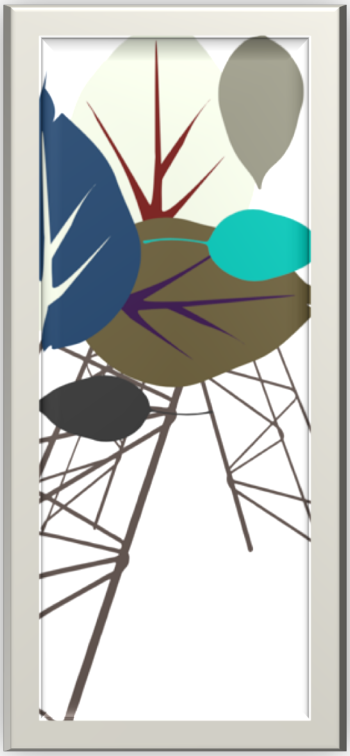
Appendix 4: The Needs Analysis

What support do you need with developing your language skills?

Appendix 5: Annotated, deidentified writing samples

Spiral 1.

Workshop 1.



Baseline writing under timed, controlled conditions:

Abstracts >200 words.

001

Google Translate used. This was interesting to note, as it was an automatic move by the student. It suggested a level of anxiety and unfamiliarity with language.

Since the Oil Crisis in the 1970s, renewable energy exploitation is viewed as a feasible solution to address the challenge of sustainability. Wave energy is an important component of renewable energy. Compared with solar and wind energy, wave energy is more consistant and predictable. However. the muture technology of wave energy conversion is still pending because the complex hydrodynate be harnessed. There is a lack of clarity in this sentence. Needs revision. A generic wave energy converter (WEC) used in wave energy industry is single-tether point absorber (PA). Its power take-off device can efficiently harvest wave energy only from PA's heave motion, while the energy of surge motion is hard to be captured. In this paper, motion-coupling is introduced into the generic single-tether PA, trying make the surge motion more compatible with power take off device. A great efficiency improvement has been found after taking advantage of motion coupling. Review this sentence for fluency. Corresponding analysis is also presented in this article.

This relies almost exclusively on simple sentences, even though some are quite lengthy. The effect of this is to give the writing a monotonous voice, decreasing the impact of the narrative on the reader. It feels stilted for two reasons: one, the lack of idiomatic language use and two, the repeated sentence type. The missing articles are typical of L2+ error patterns and alienate a L1 readership. The opening thesis statement is not picked up and referenced in the closing statement, giving a lack of cohesion to the writing. The sentences are terse to the point of not revealing significant information, leaving the reader unclear where the writer is going. No key terms are offered to engage the reader and ensure the right reader reads the abstract and then the article. No title is given to entice the reader and suggest key terms within the article, either. This suggests the writer has not fully engaged with the genre.

Alison-Jane Hunter
Tense: 'has been viewed' follows more logically from 'since'.

Alison-Jane Hunter
Should this be plural? Sustainability is inherently complex and multi-faceted, suggesting a range of approaches should be taken.

Alison-Jane Hunter
Simple spelling error

Alison-Jane Hunter
'When compared with' would be more idiomatic.

Alison-Jane Hunter
Random full stop. Should be a comma.

Alison-Jane Hunter
'Nature'? 'Mature'?– word usage. Suggests mis-hearing of correct word.

Alison-Jane Hunter
Verb missing. 'Needs to be harnessed'?

Alison-Jane Hunter
Missing article: 'the'.

Alison-Jane Hunter
Missing article: 'a'.

Alison-Jane Hunter
Missing article.

Alison-Jane Hunter
Verb form: 'hard to capture'. This needs to be in the active voice.

Alison-Jane Hunter
Phrasing is weak: 'in order to' would be more confident.

Alison-Jane Hunter
Missing article.

Alison-Jane Hunter
Phrasing: 'Significant improvements in efficiency have been achieved through…'. it's not wrong, but nor is it idiomatic.

Alison-Jane Hunter
What aspect of motion coupling?

Alison-Jane Hunter
Article missing.

002

Google Translate used. This was interesting to note, as it was an automatic move by the student. It suggested a level of anxiety and unfamiliarity with language.

Selective laser melting (SLM) is a technique, whose fundamental is stack and accumulation, using an additive manufacturing process to create 3D objects The basic working theory is that the machine generates a section shape of the work sample by scanning in the x-y plane; following that, the layer moves a layer-thickness along the X axis direction and the process starts over again, until the work piece is finished. SLM has a number of distinct attributes, such as high accuracy, wide application range, its ability to produce complicated, highly customized structures. These advantages make SLM one of the most prospective technologies. Commercially pure titanium (CpTt) and its alloy are the main researched metallic materials due to its great mechanical properties and biocompatibilities. The excellent mechanical performance arising from their low modulus, high strength to weight ratio, high specific and yield strength, facilitate their usage in the aerospace and auto industry

The project will utilize the 3D printer to fabricate titanium alloy samples By varying the processing parameters used to examine how these would influence the hardness, tensile strength, density by studying their microstructures. By doing this, hopefully the application of the material can be prompted to a broader scope on a commercial scale.

This relies on a variety of sentence types, though the various clauses do not always follow or support logically. The effect of this is that the writing is confusing and feels disjointed. The missing articles are typical of L2+ error patterns and alienate a L1 readership. You also need to be acutely aware of subject and object agreements, as well as consistency of subject agreements or you will damage cohesion irrevocably. The thesis statement appears in paragraph two, not one, and is not picked up and referenced in the closing statement, giving a lack of cohesion to the writing. The sentences are confusing due to the lack of cohesion, leaving the reader unclear where the writer is going. The use of theme and rheme would help significantly here. No key terms are offered to engage the reader and ensure the right reader reads the abstract and then the article. No title is given to entice the reader and suggest key terms within the article, either. This suggests the writer has not fully engaged with the genre.

Microsoft Off… **Deleted:** Google Translate used. This

Alison-Jane… *Who is for people, not objects*

Alison-Jane… *Noun missing and spelling error.*

Alison-Jane… *Clumsy thesis statement: where is this*

Alison-Jane… *Unclear phrasing*

Alison-Jane… *Scanning what?*

Alison-Jane… *Word choice?*

Alison-Jane… *Phrasing?*

Alison-Jane… *Word form? Distinctive?*

Alison-Jane… *Article missing.*

Alison-Jane… *Article missing.*

Alison-Jane… *Final element in a list should be*

Alison-Jane… *Word choice? Clarity?*

Alison-Jane… *Why do we need to know about metallic*

Alison-Jane… *Subject agreement? Earlier your subject*

Alison-Jane… *Re-define your subject for clarity here.*

Alison-Jane… *Again, subject agreement? Surely this*

Alison-Jane… *Strong use of paragraphing.*

Alison-Jane… *Shouldn't this be the thesis statement?*

Alison-Jane… *This dependent clause does not set up*

Alison-Jane… *Again, last in a list needs 'and' not a*

Alison-Jane… *Weak modifier.*

Alison-Jane… *Word choice?*

003

Written twice – in full. This was an interesting use of time and suggests a level of panic. It would have been more successful to plan and then write.

Fracture and fatigue analysis of cracked bodies are often performed using classical facture criteria to predict the condition of fracture rnifrfron crack-growth rate and evaluate fatigue lives of carious structural components. The classical facture criteria postulate existing critical clue of facture controlling parameter which has to be excced in order to ruitrate unstable crack propagation. However, the facture controlling parameters are evaluated based classical plane theory which are only applicable to very thin or thick plate. The purpose of this research is to develop a more reliable and accurate predictive model by incorporating the effect of plate thickness The research comprises of several aims such development of 3D model of dislocation for complicate geometry, development of 3D solution for crack in varrous structural components, and investigation the effect of plate thickness on the size of plastic zone ahead of crack-tip. It is believed that the research can advance our knowledge in fracture mechanics.

You do have a summative conclusion, which bears a relationship with the opening sentence, but the topic sentence itself is weak. There are many missing articles and places where the sequencing by number falls apart. Watch out for comma usage: punctuation would help to clarify a number of your sentences. Sometimes prepositions catch you out. Concordancing would help with this. Planning would have enabled you to have a stronger opening sentence, clearer links to the closing sentence and greater cohesion overall. A title would have drawn this together more clearly and key words would have made your audience more explicit.

Alison-Jane... *Analyses would make the sentence*
Alison-Jane... *Word form: 'classic'. "Classical" means*
Alison-Jane... *Article probably missing here.*
Alison-Jane... *?*
Alison-Jane... *Article missing here.*
Alison-Jane... *Article missing here.*
Alison-Jane... *Spelling: 'various'.*
Alison-Jane... *Word form.*
Alison-Jane... *Plural needed.*
Alison-Jane... *About – preposition choice.*
Alison-Jane... *Either this needs an article or '*
Alison-Jane... *Verb form and spelling: 'exceeded' .*
Alison-Jane... *Technical term? I can't find it online.*
Alison-Jane... *Based on...*
Alison-Jane... *Comma needed*
Alison-Jane... *Clear, effective sentence. Could this be*
Alison-Jane... *Comma.*
Alison-Jane... *Missing words: such as the...*
Alison-Jane... *Article missing.*
Alison-Jane... *Word form?*
Alison-Jane... *Article missing*
Alison-Jane... *Plural needed.*
Alison-Jane... *Spelling: various.*
Alison-Jane... *Word missing: of*
Alison-Jane... *Article missing*
Alison-Jane... *Article missing*

004

Wheelchair configurations have consistently been shown to influence propulsion technique and therefore the resultant motion. The majority of investigations have focused on daily, sub-maximal propulsion with the intention of reducing injury risk. Despite the increasing popularity of wheelchair sports, the area has received limited attention. As the aims of wheelchair sports places a greater emphasis on performance, although not neglecting injury risk, the findings from sub-maximal studies do not transfer to wheelchair sports. To address the lack of knowledge regarding configuration effects on maximal effort wheelchair propulsion, a systematic testing approach and simulation model are intended to optimize the interaction between athlete and wheelchair for performance. The process involved in achieving this is to investigate current configurations in an elite environment of wheelchair rugby, as well as the varying propulsion techniques across players of varying functional level. Using an understanding of the propulsion techniques, a systematic testing method will vary a range of configuration parameters to allow assessment of how these parameters alter propulsion and hence performance. From these results, a model that accounts for an individual players functional ability, anthropometrics and on-court role and provides a recommended seating position is desired. The development of this model will greatly aid in the understanding of athlete-wheelchair interactions for maximal effort wheelchair propulsion.

Alison-Jane Hunter
Subject-verb agreement.

Alison-Jane Hunter
Without?

Alison-Jane Hunter
The? Specifically rugby.

Alison-Jane Hunter
Levels – agreement issue.

Alison-Jane Hunter
Currently used? This is a bit open – be very clear.

Alison-Jane Hunter
Missing apostrophe.

Alison-Jane Hunter
Effort or output?

A title and key words would have matched the requested genre more effectively. The thesis statement and concluding sentence match effectively. The writing is mostly clear and has a definite sense of purpose. There are issues with subject-verb/adjective agreements throughout.

005

Open cycle gas turbines are increasingly being used in modern diverse power networks for power generation. These gas turbine's offer the ability to provide base loads in peaking conditions or when the supply in uncertain. However, these open cycle gas turbines generate higher than orthodoxy predicted noise levels. The aim of the research is to investigate the mechanics of sound propagation through hot exhaust gasses with cooler cross-flow. This investigation will employ numerical modeling and experimental testing to explore the mechanisms effecting the increase in noise levels from open cycle gas turbine's. The results will be disseminated in academic publications, as well as serve as a basis for designing noise mitigation strategies for the power generation industry.

Clear structure and line of argument. Varied sentence types engage the reader. Issues: word order, word accuracy, apostrophe use. No title for clarity and no key words to establish the audience, however note is made of its purpose, so engagement is made with a targeted audience.

a1633284
Word order. Review.

a1633284
No apostrophe. It's a plural.

a1633284
Word choice: is.

a1633284
Phrasing? Would it be worth hyphenating this compound idea?

a1633284
Add 'both' for reinforcement and balance?

a1633284
Word choice: do you mean 'effecting' i.e. 'causing' or 'affecting' i.e. 'changing'

a1633284
Apostrophe error.

006

Bearings are a common component found in every rotating machinary system and will eventually fail. However, when bearings fail, costly damage to other components, dountime and even lost of life can occur.

Industry currently uses condition base monitoring to determine the condition of the machine, but these methods can not exactly determine the condition of the machine, but these methods can not exactly determine if a bearing is damaged and the extent of the defect in an operational bearing. This is an issues as some industries, like the rail industries are required to maintain bearings at a specified condition. This research looks at the new methods that have been developed to estimate to extent of the damage within the bearing, the gaps in this literature and the new method that is being developed to determine the extend of an extended defect.

No title or key words to set out the topic and engage readers. Nice use of paragraphs. Issues: word form, spelling, subject agreements, clarity. Avoid the temptation to use many words to explain complex ideas. Avoid comma splicing. The last sentence is summative but unclear. The cohesion, therefore, is damaged.

a1633284
Spelling error: downtime.

a1633284
Word form: loss.

a1633284
Including the article here would increase flow.

a1633284
'Cannot' is one word, not two.

a1633284
Wordy: try – 'but this form of monitoring is not fully accurate'?

a1633284
You are splicing with commas and connectives here: try – 'as they cannot determine the exact extent of bearing damage and its impact on the working parts of the machine'.

a1633284
Random plural.

a1633284
This wouldn't normally be plural: review.

a1633284
Preposition error: 'in'.

a1633284
Lovely, clear phrase

a1633284
Which?

a1633284
Is this another new method, not mentioned previously? How can you clarify this? Isn't this the focus of your research?

a1633284
Word form: 'extent'?

a1633284
Just one? Or extended defects in general? Clarify.

007

Used Google translate This was interesting to note, as it was an automatic move by the student. It suggested a level of anxiety and unfamiliarity with language.

In order to express my project to clearly to others. I hope to improve my writing in sentence level and paragraph level.

- *For the sentence level, the problem for me is to express my opinions more clearly. When I write a paper, readers often confuse about what I want to express.*
- *For the paragraph level, the problem for me is to write more logical. When I write a paper or my thesis, for each paragraph I want to express one opinion. However, my expression is not logical enough. Sometimes, it's difficult for readers. At present, I often read the papers of top journals about my project. and learn their ways to express their opinions for each paragraph.*

This is really interesting as it shows both panic and misunderstanding of the task: I asked for an abstract of their work in full prose. Some of the phrasing issues are probably derived purely from using an electronic translator. The writing is painfully honest and shows that the writer has sought remediation for him/herself already but not yet found a pathway forward. There is a wide range of issues with the writing from expression, idiom to random full stops to straightforward grammatical errors. This is appropriate for the Needs Analysis, but does not set out an abstract of a thesis or journal paper, as requested. There are clear comprehension issues for this student who is obviously diligent and keen but off track at this point. Such an error would be tricky to manage if repeated in a supervision situation. I also asked for prose, not bullet points. Whilst the topic statement is useful, there is no summative conclusion here, nor are there key words, so the audience is just the researcher, not an open audience of engineering readers.

a1633284
Elegant use of a complex sentence to open.

a1633284
'At sentence level…' would be more idiomatic.

a1633284
Either 'more clearly than I do already' or just 'clearly'.

a1633284
'are often confused' – Verb form.

a1633284
Simplify to: 'about my intentions' or 'about my meaning'?

a1633284
At…

a1633284
Simplify: 'my problem is to be more logical' or 'my problem is to write more logically'.

a1633284
Opinion or idea? Normally the rule says one idea per paragraph.

a1633284
Expression? Ordering of ideas? Both?

a1633284
Avoid contractions in academic prose. Style issue.

a1633284
Random full stop.

a1633284
Random full stop.

a1633284
A more idiomatic phrasing might be: 'in order to learn from published authors' modes of academic expression'?

008

Bushfire is a critical issue to Australia, and it is becoming more frequent and dangerous due to the climate changing There are two main types of combuctions in bushfires: smouldering and flaming combustion, but the understanding on smouldering combustion . in bushfire is still limited. Smouldering combustion is a low-temperature and slow form of combustion, which does not show any flame. Smouldering is a fire hazard, and once ignited, it is diffcut to find and extinguish it, because it does not have obvious . indications such as high temperature or visible flame. However, smouldering combust can transition to flaming combustion under . certain conditions. The initiation . of smouldering combustion normally requries less energy than flamg combustion. Hence, it is easier to . start smounldy combustion . than flamg combustie.

In bushfires, smouldering combustion . provides . a pathway for solid fire to start flaming combustion It is important . to . understand under what conditions does smoudlery ignition . start, and the . transition . from . smouldering . to flaming . combustion . occur. Hence, this research will . focus . on the initiation of smouldering . combustion and . its transition to flaming combustion.

This piece contains serious issues, which, if reproduced in supervisions, cause much anxiety. There needs to be an understanding of basic punctuation, consistency of word form and agreement between subjects. The piece has no title and no key words, so establishing an audience doesn't happen. There is a summative statement and a sense of logical progression through the writing, but the expression is so weak, it is seriously difficult to understand the narrative.

277

a1633284	*Word order: would 'an issue critical to*
a1633284	*'climate change' is more idiomatic?*
a1633284	*Do you mean 'combustion'? In which*
a1633284	*Unnecessary article.*
a1633284	*Preposition error: of*
a1633284	*Random full stop.*
a1633284	*'In bush fires' or 'under bush fire*
a1633284	*Spelling.*
a1633284	*Random full stop.*
a1633284	*Word form: 'indicators'?*
a1633284	*Random full stop.*
a1633284	*Combustion*
a1633284	*Random full stop.*
a1633284	*Random full stop.*
a1633284	*Random full stop.*
a1633284	*Spelling.*
a1633284	*Spelling.*
a1633284	*Random full stop.*
a1633284	*Spelling.*
a1633284	*Random full stop.*
a1633284	*Spelling.*
a1633284	*Spelling.*
a1633284	*Good use of paragraphing.*
a1633284	*Random full stop.*
a1633284	*Random full stop.*
a1633284	*Unclear phrasing.*
a1633284	*Random full stop.*
a1633284	*Random full stop.*
a1633284	*'what the effects of specific conditions*
a1633284	*Random full stop.*
a1633284	*Spelling.*
a1633284	*Random full stop.*
a1633284	*How smouldering ignition starts?*
a1633284	*Oxford or redundant comma before a*
a1633284	*Random full stop.*
a1633284	*Random full stop.*

009

About one third of the worlds population relies on the combustion of biomass fuels to satisfy their cooking and heating needs. A large part of these people use traditional methods like open fires and simple cookstoves. These methods result in the emission of large amounts of products of incomplete combustion, which cause health and environmental problems. In the last three years research here at the University was performed on one specific type of cookstove, named top-lid up-draft stove. This type of stove has been shown to petentially reduce emissions of incomplete combustion significantly Emissions reduction is realised by the separation of the thermochemical decomposition of the solid biomass into gaseous fuel and the combustion of these gaseous compounds, in time and location. For the research a test rig was constructed, which allows various combustion relevant parameters to be individually altered With the last years two honor's projects and one master's project were conducted using this rig. This work has been presented within the limits of the faculty but net yet been made available to the greater public. To be presentable in a journal all data has to be re-assessed and re-analysed, as well as put in an exceptable format. The challange of establishing the most valuable results which present progress in the field and which are of interest to other researches is ongoing

No title or key words, so the audience is not made explicit. There are several idiom issues, spelling and punctuation errors. The ideas are fluent but not controlled. The topic sentence is strong and the summative sentence links well but shows very poor expression.

278

a1633284	*Missing apostrophe.*
a1633284	*'a significant number...' would be more*
a1633284	*Comma to mark the end of the*
a1633284	*Has been undertaken?*
a1633284	*Article missing.*
a1633284	*Spelling.*
a1633284	*Split infinitive.*
a1633284	*Revise word order: what about – 'This*
a1633284	*Through – preposition use.*
a1633284	*Oxford comma.*
a1633284	*Clarify: quickly, across time ?*
a1633284	*Comma to show the end of the*
a1633284	*Is it worth hyphenating this compound*
a1633284	*Word order – the adverb, individually,*
a1633284	*Idiom: 'Recently, two Honours*
a1633284	*Incorrect use of the apostrophe.*
a1633284	*Capital letter needed.*
a1633284	*Capital letter needed.*
a1633284	*Incorrect apostrophe.*
a1633284	*Word choice: 'undertaken'?*
a1633284	*Word choice: 'confines'?*
a1633284	*Missing capital letter.*
a1633284	*Verb form: 'but have not yet been'...*
a1633284	*Word choice: 'wider'.*
a1633284	*Word form: 'presented'.*
a1633284	*Comma needed to mark the end of the*
a1633284	*Missing article.*
a1633284	*Style: 'presented'?*
a1633284	*Word choice: 'acceptable'.*
a1633284	*Spelling.*
a1633284	*Convoluted sentence. Revise.*
a1633284	*Comma needed.*
a1633284	*Spelling.*

010

Pipe Condition Assessment using Pressure Transients and Acoustics Research

Abstract

Clean and reliable water supply is essential to every city and town. However, the water distribution systems that deliver such precious natural resource are often poorly maintained. This reseach is to propose a new non-invasive pipe condition assessment technique to detect the structural defects within the pipes, for instance leaks and pipe wall thinning. This research is significant because it is the first to combine pressure transients and acoustics for pipe condition assessment. The benefits of doing so is twofolds: Firstly the combination will allow broader frequency spectrum to be collated and examined for pipe condition assessment. Secondly the combination will bring together the benefit of analysing either pressure transients or acoustics individually. The overall expected outcome of this research is to efficiently and accurately assess pipe condition at a reasonably low cost.

This is a sophisticated piece of writing in many ways, underpinned by very clear thinking. There are minor agreement issues and a couple of spelling errors. There are some fluency issues where a sentence could be shortened for clarity and accuracy. From an EAP perspective, the moves across the abstract are clear, ordered and effective. By setting it out accurately from the start, it was much simpler to ensure cohesion throughout. The topic sentence, moves and summative statement all match through effectively.

a1633284
Excellent: clear, concise title. Renders the article focused on a defined audience.

a1633284
By nominating the form, you keep your voice on track to match your audience and purpose.

a1633284
Persuasive, emotive opening to engage the reader.

a1633284
Missing indefinite article>

a1633284
spelling

a1633284
The purpose of this research is to propose, analyse and refine…

a1633284
Comma for emphasis between elements of the noun phrase?

a1633284
Would you strengthen that with a semi colon? It would show the balance of power between the two clauses.

a1633284
Excellent: clear move 2 in the argument. Would you put it into a new paragraph for emphasis?

a1633284
Subject-verb agreement. 'Are'.

a1633284
Word form/spelling: 'twofold'.

a1633284
'Spectra'? Or 'a broader frequency spectrum…'?

a1633284
Comma to show the dependency of the clause.

a1633284
'To enable the efficient and accurate assessment of the pipe condition…'? This allows you to use nominalization to enhance the strength of your summation, whilst avoiding a double split infinitive.

011

My topic is the investigation of the acoustic absorption mechanisms of nanomaterials, focusing on lower frequencies than previously examined Due to the limitations of electron microscopy visual observation of the interactions between acoustic waves and nanomaterials is not possible. Hence, modeling of such a system is required instead. Unfortunately limitations of existing models prevent simulations from reaching both the time and length scales required, concurrently. For this reason the investigation of various speedup techniques and hybrid models is required during the early stages of the project, thus allowing the interactions of interest to be observed and the associated mechanisms to be determined.

So far, a number of techiques have been investigated including substitution of an analytical sound source, the use of a simple force field between the atoms, multiple time-stepping and processor-balancing. These techniques have been found to produce a significant speed-up in the system, with a speedup factor of approximately 125. This has allowed longer time and length-scales to be modeled, but is insufficient to permit the audible frequency range and larger nanomaterial structures to be simulated. Hence, hybrid continuum-atomistic modeling and equivalent continuum models which should permit even greater gains, but are more involved processes, are of interest.

Once these techniques have been incorporated into the model, experimental data will be used to verify that the sound absorption, calculated from the simulation results is accurate. It is at this point that the mechanisms involved in the acoustic absorption may be investigated, for the audible frequency range.

A title and key words might have given even greater clarity of voice and audience. Your thesis and summative statements match beautifully, and you have clear moves across each section. Your writing is fluent and cohesive throughout. Watch out for comma pairs to mark off additional information or interpolations. They clarify the core of the meaning. Discourse markers are frequent and well controlled.

a1633284
First person voice? Who is your audience? Is it the researcher of a journal/thesis editor or reader?

a1633284
Very clear opening statement.

a1633284
Comma needed to delineate the dependent clause.

a1633284
Very clear moves, signaled by discourse markers.

a1633284
"acceleration"? - style

a1633284
'thereby'?

a1633284
Helpful paragraphing.

a1633284
Comma or colon before a list?

a1633284
To put a limitation in so early gives substance to your moves.

a1633284
First of the comma pair needed.

a1633284
Commas to show the interjected clause.

012

Noise emission from wind turbine has been an issue and concern for residents in their vicinity. It has been proven that with increasing in size of the turbines the low frequency content (LFN) of the noise signature augments. LFN from wind turbine can travel large distances and can affect the residents in terms of annoyance and sleep disturbance. In this study a statistical approach is used to investigate the mechanism associated with this annoying noise through studying public surveys of the residents. It has been concluded that the noise is mostly perceived downstream of the turbine wich is in accordance with directivity pattern of the turbulent-inflow-noise or stall-noise. It has been also concluded that the turbulent structur in wake can significantly affect the noise propagation. However, due to complenity of the wake structure more studies should be conducted to investigate its effect on noise directivity.

No title or key words to clarify the audience. Clear topic sentence leads to the summative statement. The moves are pedestrian and the narrative a little stilted due to the regular use of simple sentences. Where richer structures are used, the interpolations can be clumsy due to their positioning. There are a number of spelling and subject agreement errors throughout the piece.

a1633284
Plural needed

a1633284
Comma.

a1633284
'with an increase in the size…'?

a1633284
Missing article.

a1633284
Comma.

a1633284
Lovely word choice.

a1633284
Plural.

a1633284
Comma.

a1633284
Tense?

a1633284
Comma.

a1633284
Spelling! (British kids are taught to say which witch is which to help them remember!)

a1633284
Article missing

a1633284
Word order – 'it has also been concluded…' Then review your tense sequence throughout the section.

a1633284
Spelling.

a1633284
Do you mean 'the wake of the turbulent structure can…'? Word order.

a1633284
Article not needed here.

a1633284
Article needed.

a1633284
Spelling.

a1633284
Second of the pair of commas needed here.

012

Noise emission from wind turbine has been an issue and concern for residents in their vicinity. It has been proven that with increasing in size of the turbines the low frequency content (LFN) of the noise signature augments. LFN from wind turbine can travel large distances and can affect the residents in terms of annoyance and sleep disturbance. In this study a statistical approach is used to investigate the mechanism associated with this annoying noise through studying public surveys of the residents. It has been concluded that the noise is mostly perceived downstream of the turbine wich is in accordance with directivity pattern of the turbulent-inflow-noise or stall-noise. It has been also concluded that the turbulent structur in wake can significantly affect the noise propagation. However, due to complenity of the wake structure more studies should be conducted to investigate its effect on noise directivity.

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a1633284
Do you mean 'the wake of the turbulent structure can…'? Word order.

a1633284
Article not needed here.

a1633284
Article needed.

a1633284
Spelling.

a1633284
Second of the pair of commas needed here.

013

The aim of this research is to develop an alternative control system to reduce the skin friction drag experienced in the turbulent boundary layer. This research focuses on the turbulent boundary layers specifically due to its importance in the aerospace industry, including planes, and helicopters to name a few. Aerospace devices tend to be situated in the turbulence regime due to high speed and Reynold's number they operate in. This turbulent boundary layer results in a dramatic increase to the shear stresses, which are directly linked to the skin friction drag, the greatest contribuer to drag for aircrafts.

The specific pot of the boundary layer we are aiming to target are the coherent structures in the boundary layer. These structures comprise 70% of the total stresses in the inner wall region. It is envisioned a reduction in these structures will cause a decreese in the total shear stresses responsible for the skin friction drag.

This reduction is to be achieved using an array of micro-cavities to absorb part of the energy spectrum of the structures or breakdoan the structures . by being excited due to the grazing flow. Such a reduction is deemed achievable due to the micro size of each cavity, which will only affect the micro structure of the coherent structures. but leave the overall flow unaffected.

Alison-Jane Hunter
Of what? Although this is a grammatically correct and clear sentence, it needs context.

Alison-Jane Hunter
Subject agreement.

Alison-Jane Hunter
Article missing.

Alison-Jane Hunter
Of what?

Alison-Jane Hunter
Part? Shouldn't this be plural too?

Alison-Jane Hunter
Is your supervisor ok with first person narrative? Otherwise 'under consideration' would make it impersonal and more objective.

Alison-Jane Hunter
Spelling.

Alison-Jane Hunter
Insert 'by'.

Alison-Jane Hunter
Spelling.

Alison-Jane Hunter
Random full stop.

A title and key words would have clarified the audience. The topic sentence is missing, meaning there is little context for this work. The summative sentence is clear and makes a link to the opening sentence. The penultimate sentence lacks clarity. There are issues with spelling and with subject agreements that lead to confusion. Check your voice, so that it matches your audience and purpose.

014

Stress Corrosion Cracking (SCC) in gas pipelines is a phenomenon which has the potential to cause rupture and subsequent loss of product. Through prior research, it has been foud that the texture in pipes has a strong impact on the liklihood of SCC occurence and that by altering the texture during the manufacturing process instances of SCC can be reduced. This work aims to show how by altering certain manufacturing conditions, the texture and subsequen't SCC resistance can be controlled leading to manufacturing processes which can provide pipes with an in-built resistance to SCC.

This is essentially very clear. A title and key words would have clarified your audience. Your topic and summative sentences link well. Check your control of punctuation.

Alison-Jane Hunter
Spelling.

Microsoft Office User
Spelling.

Microsoft Office User
Spelling.

Alison-Jane Hunter
Do you need a comma here? They should be in pairs or implied pairs (i.e. a full stop takes the place of a comma, or it is implied at the opening of a phrase.

Alison-Jane Hunter
The first comma should go here.

Alison-Jane Hunter
Incorrect apostrophe use.

Alison-Jane Hunter
Comma here? Or even a semi colon?

015

Low salinity flooding (LSF) is among new methods that have been applied in oil and gas industry to enhance oil recovery and they are termed as tertiary recovery or enhaned oil recovery methods. LSF is considered one of the most economical and also environmentally friendly applications, though it is considered very new and dates back to 20 years. As a new method, the mechanism behind the effect is not very well understood and more research needs to be done. So far researchers have proposed different hypotheses but not a general theory has been suggested to cover all senarios and systems. The current research's objective is to conduct an experimental investigation to provide better understanding and also more insights into the LSF method.

Alison-Jane Hunter
Article missing.

Alison-Jane Hunter
Spelling.

Alison-Jane Hunter
Close word repetition.

Alison-Jane Hunter
'only'?

Alison-Jane Hunter
Comma after dependent clause.

Alison-Jane Hunter
Phrasing: replace with 'no...'

Alison-Jane Hunter
Spelling.

Alison-Jane Hunter
Flow? The objective of the current research would focus on your objective as the primary target.

This is clear but feels a little clumsy. If you reconsider word order and repetition, it would be more targeted. A title and key words would also help to ensure a clear focus on your specific audience and purpose. Review punctuation in order to support clarity, also.

016

- *Electric fields have been used to enhance solid-liquid seperation since the 1800's.*
- *The underlying science of electrochemistry has developed over the years.*
- *Electrokinetics plays an important part in the behaviour and characteristics of colloids.*

Alison-Jane Hunter
Spelling.

Alison-Jane Hunter
Mis-use of the apostrophe.

* at this point, I asked again for full prose*

Phenomena such as electrophoreris, electro-osurosis and electro-coagulation can be used to concentrate and dewater microalgae cultures.

In this paper I will examine the use of electrokinetic techniques in harvesting micoalgae culture, specifically with a view to understanding the requirements and engineering constraints of large-scale applications such as production of biomass for bio-fuels.

Alison-Jane Hunter
Is your supervisor happy with first person voice?

Alison-Jane Hunter
Plural?

A title and key words would have clarified this writing and ensured you wrote with a suitable voice for your specific audience and purpose. Review your paragraphing: this is really bullet points without the bullets! Check about the use of first person: many journals don't accept it. There is no clear topic sentence to which your summative statement can refer back, which hinders cohesion.

Appendix 6: Sentences to correct

a. ***The published sentences:***

1. However, a point absorber that oscillates in two modes (heave/surge or heave/pitch) with optimal control parameters can theoretically capture three times more power than a heaving device, achieving the maximum power absorption for such types of WECs.

2. Site visits are an integral part of the IIWE program, and provide the main opportunity for networking with industry professionals and exploring possible future employment whilst gaining an insight into the companies.

3. The mechatronic devices built for the competition are not technically robots they do not have the required degrees of freedom or re-programmability to be classified as such, but for the general public the distinction is moot.

4. One of the most frequently utilized theoretical approaches for investigating crack tip plasticity effects is the Dugdale strip-yield model.

5. Radiation processes are strongly non-linear, and highly complex and the accurate modelling of such processes is a difficult and time consuming task as a consequence of the large number of physical parameters defined for the heat transfer media.

6. Compensation of changing environmental and operational conditions (EOC) is often necessary when using guided-wave based techniques for structural health monitoring in real-world applications.

b. ***The sentences with titles and authors:***

1. However, a point absorber that oscillates in two modes (heave/surge or heave/pitch) with optimal control parameters can theoretically capture three times more power than a heaving device, achieving the maximum power absorption for such types of WECs.

An optimal arrangement of mooring lines for the three-tether submerged point-absorbing wave energy converter.

N.Y. Sergilienko, B.S. Cazzolato, B. Ding, M. Arjomandi.

2. Site visits are an integral part of the IIWE program, and provide the main opportunity for networking with industry professionals and exploring possible future employment whilst gaining an insight into the companies.

Educating and promoting women in engineering through an international conference for undergraduate and postgraduate engineering students.

E. Fahey, D. Missingham.

3. The mechatronic devices built for the competition are not technically robots they do not have the required degrees of freedom or re-programmability to be classified as such, but for the general public the distinction is moot.

Engaging International Students Through the Setting of Challenging Mini Projects.

S. Grainger, J. Judge, C. Kestell, A. Blazewicz.

4. One of the most frequently utilized theoretical approaches for investigating crack tip plasticity effects is the Dugdale strip-yield model.

Effect of a variation in material properties on the crack top opening displacement.

J. Codrington, A. Kotousov, D. Chang.

5. Radiation processes are strongly non-linear, and highly complex and the accurate modelling of such processes is a difficult and time consuming task as a consequence of the large number of physical parameters defined for the heat transfer media.

A comparative approach of inverse modelling applied to an irradiative batch dryer employing several artificial neural networks.

A. Mirsepahi, L. Chen, B. O'Neill.

6. Compensation of changing environmental and operational conditions (EOC) is often necessary when using guided-wave based techniques for structural health monitoring in real-world applications.

Reconstruction of baseline time-trace under changing environmental and operational conditions.

P. Aryan, A. Kotousov, C.T. Ng, S. Wildy.

Appendix 7: Paragraphs to correct

Role of spase is one of the the fundamental aspects of food security and this could be considered carefuly in food security research policy linkages. However unrespective in attribute importance to the spatial matters, current food security analyses and policies relate to nourishment in India mainly focus on individual/household level alone. Furthermore it is possible that climate change impact food security and impact needs to consider the spaces dimensions. Important to understand where an under the natural and socioeconomic circumstances including climate change people become vulnerable to low food security in country fully at subnational level. This aims to develop the spatial approach for food security assessment in Indai. The specific objectives of the study are: 1 inform the national data sources on food security, 2 review food security in india, 3 understand spatial matters of climate change-impact on food security, 4 propose a theoretical model for food security analysis, especially at sub national level. Present study is informed by a range of national datas source off food security which are available in India highlighted limitations on obtaining data on food security spatially. Paper argue that a sytematical approach required to adress food security and climate spatials in India combining spatial-temporal data with effective spatial approach through 3 steps in research policy linkages. The review concludes that such a approach should be used to underpin food policy implications to offer research based information about the necessity for improvement in food security at sub national level.