

# Guidelines for developing and using e-assessments with vocational learners

## Project overview



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“Mā te rongō, ka mōhio; mā te mōhio, ka mārama; mā te mārama, ka mātautau”

From practice comes understanding, from understanding comes knowing, from knowing comes expertise.

## Summary

This project brought together a team of vocational educators from three Institutes of Technology or Polytechnics (ITPs) and an iwi-led tertiary partnership, to create a set of guidelines for the development and implementation of e-assessments for learning. As New Zealand qualification outcomes have shifted from competency-based to graduate profile outcomes-based qualifications, there is a need to support students' learning towards meeting graduate profiles. Assessments for learning are key components of sound learning programmes. Assessments for learning, also called formative assessments, are planned learning activities which lead to occasions for learners or teachers to check on learning progress. Opportunities for feedback provide learners with advice to judge their learning and plan towards future improvements, leading to increased learner achievement and efficacy.

The affordances provided by digital devices, tools and apps, increase opportunities for the implementation of useful assessments for learning which meet learners' needs. Digital technologies also allow access to some of the difficult to describe, or measure, skills and dispositions, which underpin vocational education. These 'invisible' attributes contribute towards learners 'becoming' (i.e. attainment of an occupational identity) as they progress towards meeting the graduate profile outcomes defined by NZ qualifications.

For this project, seven sub-projects were developed, which implemented e-assessments for learning activities using a range of pedagogical approaches and digital tools. These e-assessments for learning, supported feedback mechanisms to learners. E-feedback was made accessible to the learners through the affordances provided by digital technologies. For example, e-feedback videos or learning analytics from VR simulators were used to accelerate the learning of skills and dispositions. Learners were able to access e-feedback from a range of supporters including their tutors/teachers, their peers, and other experts. These opportunities for multimodal feedback (through images, audio recordings, VR environments, etc.) provided learners with important information to assist with deliberate practice.

The guidelines are a distillation of the learnings achieved through iterations of Participative Action Research (PAR) cycles by each sub-project team. These guidelines can be used to support the development, implementation and evaluation of e-assessments for learning within vocational education.

As dictated by the findings, the guidelines provide a framework for the e-assessment process:

### **Selection and Development of e-assessments for learning**

- 1) Align graduate profile and learning outcomes to assessments for learning.
- 2) Explore and identify the difficult to articulate, undescribed learning outcomes required by learners to 'become'.
- 3) Match e-tools to learning outcome/s, with emphasis on enabling the 'hidden' multiliteracies and modalities of learning.

### **Deployment**

- 1) Ensure teaching team capability.
- 2) Prepare the learner.
- 3) Make learning overt.
- 4) Leverage off learning analytics, for teachers and learners.

### **Implementation**

- 1) Review after each iteration.
- 2) Scaffold learner capability to use e-feedback so that it becomes personalised to their own learning.

### **Evaluation**

- 1) Re-evaluate holistically the learning goals, the e-tool/s and the resulting learning.
- 2) Keep up with the play on e-tools and their capability to support e-feedback.

## Glossary of concepts and terms used in this report

*Ākonga*: student, pupil, learner or protégé (see Apanui & Kirikiri, 2015)

*Assessments for learning*: an opportunity, during a learning activity, for the learner (and teacher) to check progress of learning – see feedback below (see Assessment Reform Group, 2002)

*Asynchronous*: learning through digital networks, which occurs at a different time to when a learning event has been broadcasted – see synchronous below for the antonym (opposite meaning)

*Authentic learning*: realistic/real-world learning

*Bring your own device (BYOD)*: learners bring their own digital device and use it to enhance learning

*Competency-based assessments*: criteria/standards-based check on learning

*Digital fluency vs digital literacy*: digital fluency requires digital literacy. Teachers and learners with digital literacies are able to use digital technologies and know what to do. Teachers and learners with digital fluency are able to decide when, how and why a tool is used to provide a required objective (see Miller & Bartlett, 2012)

*e-assessments*: checking learning progress or attainment, which is assisted, enabled and/or enhanced by digital technology

*e-tools*: in this project, the term e-tools encompasses the hardware, or device, and the software, app or platform of technology-enhanced learning

*Embodied learning*: when skills and attributes become embedded into individual's ways of being and doing (see Barsalou, 2008)

*Efficacy (of learners) / self-efficacy*: the belief in one's abilities or capabilities to succeed

*Feedback – formative / feedback loop*: information provided as learning progresses. The loop consists of feed up (Are we on the right track?), feedback (How are we going?) and feed forward (What do we need to do to get better?) (see Hattie & Timperley, 2007)

*Formative assessments*: check points as learning progresses – see above for feedback

*Graduate profile outcomes*: in NZ, all qualifications between levels 1–6 are based on learning which will meet graduate profile outcomes, i.e. what is the graduate able to do on completion of the qualification (see Chan, 2016)

*Heutagogical learning*: self-directed or self-determined learning, whereby learners take responsibility for planning and directing their learning (see Hase & Kenyon, 2013)

*Inter-psychological processes for learning*: refers to the many sociocultural influences on learning (e.g. from peers, other workers, experts, etc.) (see Billett, 2014)

*Intra-psychological processes for learning*: learning through making meaning and responding to the feedback provided through inter-psychological relationships (see above); to practise, and eventually master, holistically, occupational or social skills, knowledge and dispositions (see Billett, 2014)

*Kaiako*: tutor, teacher or instructor who is the enabler of learning (see Apanui & Kirikiri, 2015)



*Learning as becoming*: holistic learning leading to identity transformation (see Hodkinson, Biesta & James, 2008; Chan, 2013)

*Mimesis / Mimetic learning*: learning through observation, imitation and practise (see Billett, 2014)

*Multiliteracies*: refers to two major aspects of literacy. The diversity of linguistic foundations of learners and the multimodal forms of linguistic expressions and representation (see The New London Group, 1996)

*Multimodality*: communication and skills involving the visual, aural, tactile, body stance and other bodily sensations (see The New London Group, 1996)

*Naturally occurring evidence*: items which are gathered by learners through authentic learning

*Networked learning*: learning, usually enabled by digital affordances, encompassing local and international connections (see Goodyear, 2005)

*Operating systems (OS)*: the underlying software which supports computer or mobile device function. The main systems used are Android which supports Google Suite or Google for Education; iOS for Apple computers, and Windows for business and personal computers (PCs)

*Situated learning*: learning based on real world examples (see Lave & Wenger, 1991)

*Sociocultural*: refers to society and culture and its contribution to learning (see Lave & Wenger, 1991)

*Sociomateriality*: recognises the facets of life including the environment, tools, materials and technologies which contribute to how learning occurs (see Fenwick, Edwards & Sawchuk, 2011)

*Synchronous*: learning through digital networks, which occurs at the same time as a learning event is being broadcasted

*Tēina*: younger brother, sister or cousin (see Apanui & Kirikiri, 2015)

*Tuākana*: elder brother, sister or cousin (see Apanui & Kirikiri, 2015)

*Sub-projects*: The guidelines are constructed from data gathered through the development and deployment of seven vocational education teaching and learning studies. The term sub-project refers to these studies

*Summative assessments*: a check on learning which contributes to a final grade

*Virtual Reality (VR)*: computer-generated scenario, which simulates real experience through the senses(see Fowler, 2015)

*Work Integrated Learning (WIL)*: Learning in the workplace through work-based attachment

## Key to sub-projects

Examples and findings from the sub-projects are embedded through the report. The following icons are used to identify the contributions made by each sub-project. Titles, researcher/s and institute are also provided here and more comprehensive details of each project are provided in the appendices.



### MULTIMEDIA USE IN LEARNING HOW TO KAYAK



Steve Chapman, *Outdoor and Sustainability Education*



### E-ASSESSMENT OF WORK-INTEGRATED LEARNING IN QUANTITY SURVEYING



Keith Power, *Construction and Quantity Surveying*



### DEVELOPING REFLECTIVE PRACTICE OF LEVEL 4 COOKERY STUDENTS THROUGH SENSORY ANALYSIS OF FOOD



Cheryl Stokes, *Hospitality and Tourism*



### ROLE-PLAY/SIMULATIONS IN AERONAUTICAL ENGINEERING UTILISING REFLECTIVE AND PROBLEM-BASED LEARNING AND LEARNING FROM ERRORS



James Gropp and Aaron Lyster, *Aeronautical Engineering*



### SUPPORTING TUĀKANA/ TĒINA RELATIONSHIPS DURING LEARNING OF CARPENTRY SKILLS



Kym Hamilton, *He Toki*



### VIRTUAL WELDERS AND THEIR EFFECTIVENESS IN DEVELOPING WELDING SKILLS: STUDENT PERSPECTIVES



Lee Baglow and Chris Lovegrove, *Automotive Engineering*



### IMPROVING CARPENTRY STUDENTS' SPATIAL AWARENESS SKILLS AND ATTITUDINAL APPROACHES TO WORKPLACE SAFETY



Kamuka Pati and Alan Warburton, *Carpentry*

## Introduction

This project was commissioned and funded by Ako Aotearoa and the New Zealand Qualifications Authority (NZQA). The project has produced guidelines to inform the development and deployment of e-assessments for learning. The project, which envisioned e-assessments for learning as contributing towards the learning success of Levels 2–5 vocational learners, was situated either on or off-campus. The collaborative project included teams from Ara Institute of Canterbury, Nelson and Marlborough Institute of Technology (NMIT), Unitec, and an iwi-led tertiary partnership, Te Tapuae o Rēhua, with the programme He Toki ki te Rika – Māori trades training. The programmes included in the project provide vocational pathways into Construction and Infrastructure (carpentry, quantity surveying), Manufacturing and Technology (aeronautical engineering, automotive, fabrication) and Services (hospitality and cookery). Given the multimodal and kinaesthetic characteristics of the participant disciplines, the guidelines developed provide direction for the implementation and deployment of multiliteracies-based e-assessments with a focus on e-feedback, within the Aotearoa/NZ bicultural context.

### Rationale for the projects' approaches

In this section, the rationale, background and objectives of the project are presented.

#### **Learners need to be prepared for the future of work**

The challenges presented by the future of work require all people to be prepared for ongoing learning through life as occupations wax and wane. Everyone will require continual retraining and learning to be able to work in changed, constantly evolving or new occupations (Productivity Commission, 2017). Therefore, as summarised by Gros (2016, p8), the nature of learning will become more learner-centred, individual and social; with personalised and tailor-made learning opportunities availed to assist with the ongoing professional learning needs of individuals and organisations. Thus, there is a need to develop innovative pedagogical concepts to assist all citizens to access flexible and dynamically reacting learning.

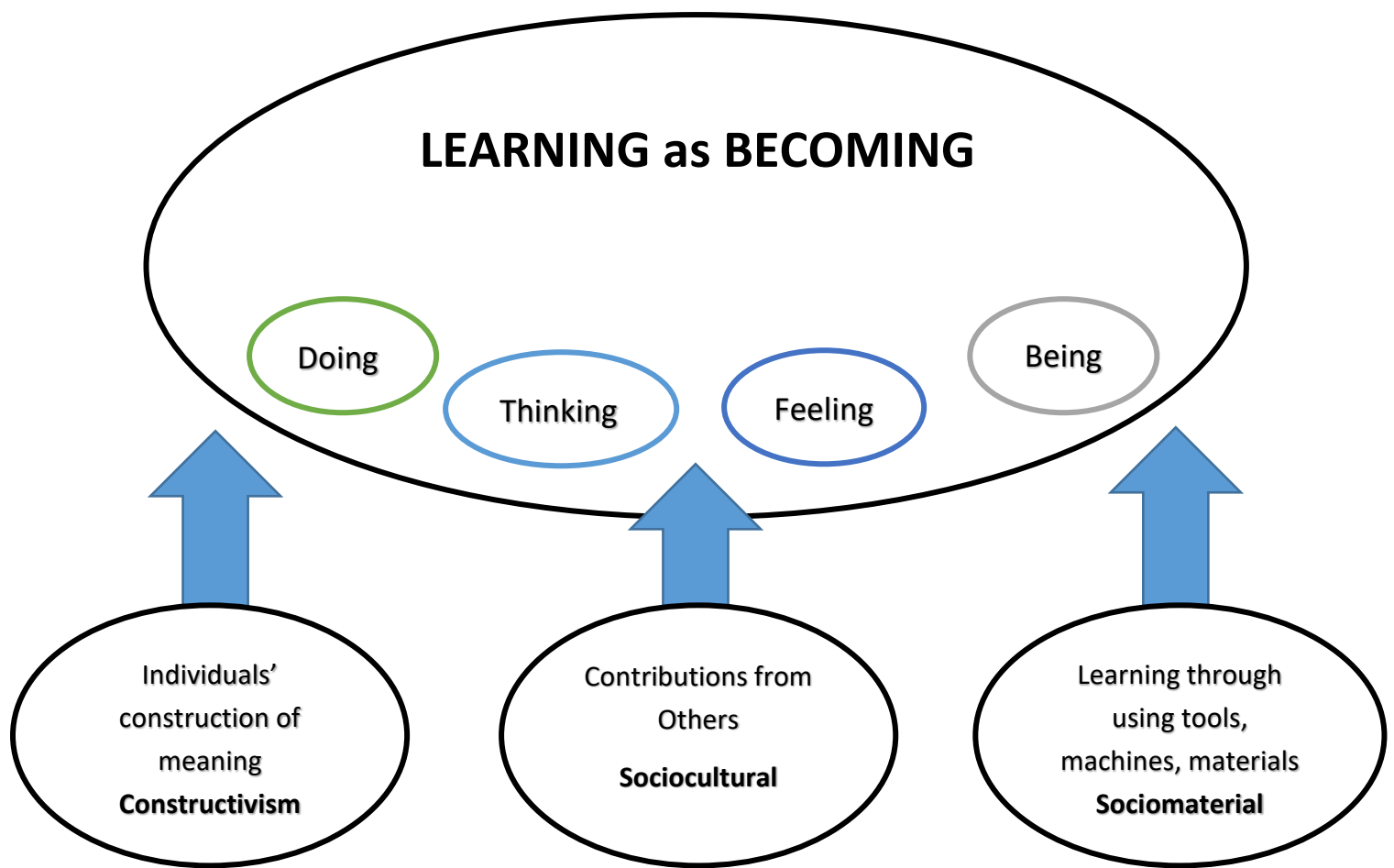
#### **Shifts in understanding learning**

Accompanied by the need to shift education towards preparing learners for the future, a better understanding of how learning is enacted has been achieved, over the last two decades, through contributions from neuroscience, neurobiology, psychology and educational research (Barsalou, 2008). In summary, humans learn through both

inter-psychological and intra-psychological processes (Billett, 2014). With inter-psychological processes, sociocultural influences on learning (e.g. from peers, other workers, experts, teachers, etc.) and sociomaterial contributions (e.g. through the 'messages' availed from tools, materials, machines, the spatial environment, etc.) provide learners with feedback to assist with initial attainment and fine-tuning of learned skills, application of knowledge to task completion and the modelling of dispositional occupation traits. Individuals utilise intra-psychological processes to make meaning and respond to the feedback provided through their inter-psychological relationships, to practise and eventually master holistically the skills, knowledge and dispositional components supporting eventual mastery (Billett, 2014). Learning the skills required to practise a trade occurs through active engagement with work tasks. Through deep involvement with trades work over time, the various 'messages' or the feedback individuals receive from the people they work with and, importantly, also the materials, environment, tools and machines they interact with daily (e.g. the sociomaterial contributions to learning (Fenwick, Edwards & Sawchuk, 2011)), enable trades skills to be learned and eventually become 'embodied' (Barsalou, 2008).

### **Qualifications change of focus towards more holistic outcomes**

NZ's shift from competency-based to graduate profile outcomes in qualifications (Chan, 2016) have provided the impetus to consolidate and improve assessment practice across the NZ vocational education sector. Moving from narrow task-based assessment, as framed by competency-based qualifications, towards utilising authentic and holistic assessment approaches implicit in new NZ qualifications' graduate profile outcomes, requires changes in teaching, learning and assessment practices. A focus on meeting graduate profile outcomes allows for the development of project-based or problem/inquiry-based learning, enabling graduates to meet learning outcomes aligned to industry needs. Assessments for learning (i.e. formative assessment or assessments as learning), as opposed to assessments of learning (i.e. summative), means putting emphasis on learning. Assessment for learning approaches, which include self, peer, sociomaterial (e.g. from the environment, tools, machines and materials) and tutor feedback, provide mechanisms for learners to learn ways of doing, feeling and thinking, which are aligned to conceptualisation of 'learning as becoming' (Chan, 2013 – see diagram 1 for summary).



*Diagram 1: Summarising 'learning as becoming' (from Chan, 2013)*

## **Difficulties in pinning down ‘becoming’**

Although graduate profile outcomes are broader in scope than previous qualifications based on the completion of atomised ‘unit standards’, many of the fine and nuanced aspects of occupational skills, knowledge and dispositions, are only inferred within national qualifications. There are many reasons for the inability of qualification systems to quantify the complexity of learning required to attain occupational skills, knowledge and attitudes or dispositions. Part of the challenge is the difficulty of ‘making thinking visible’ (Brown, Collins & Duguid, 1989). Other reasons include the lack of oral or written language to describe the fine distinctions of motor and manual skills (Marchand, 2007), and the subsumption of the ‘tacit knowledge’ components of learning (Gamble, 2001) due to the ‘embodied nature’ of human learning (Barsalou, 2008). For example, Marchand’s (2007) study of students learning how to manufacture furniture reveals the many skills required by students to be sensitive to the materials they use to construct the furniture (e.g. tables, chairs, etc.). The engagement of learners’ senses are required to evaluate subtle differences relating to the quality and selection of materials (e.g. the types of wood, glues, varnishes), the ways in which tools inter-relate to the materials (e.g. mechanical and manual tools) and the environment (e.g. temperature, humidity) within which carpentry and joinery skills are enacted. Many of these specialised but highly important skills are only inferred in national qualifications. However, these multimodal skills are crucial contributors towards how well woodworkers complete their occupational tasks. To become proficient craftspeople, novices have to learn the tacit skills and knowledge “which are a realm of skills and knowledge perhaps beyond human verbal capacities to explain” (Sennett, 2008 p. 95).

## **Contribution of assessments for learning**

Inter-psychological processes are a key to assisting individuals’ intra-psychological development. Assessments for learning are one useful method of gathering the pertinent feedback required by individuals to learn new, unfamiliar or complex tasks, concepts or dispositional traits. With the advent of digital tools, e-assessments for learning are well-placed to support learners through ready collection of learning evidence, supported with access to and archival of feedback (Terrell et al., 2016). This feedback may be from the individuals themselves through access to the recordings of their practise activities, which may be annotated as part of reflective practice or deliberate learning processes. Importantly, feedback may be availed through timely comments from observers, including peers, tutors/teachers, mentors, trainers, etc. Technology also provides feedback through

device analytics (e.g. response times, number of attempts, error rates, etc.) or artificial intelligences monitoring differentiated or individualised learning programmes. Therefore, well-designed e-assessments for learning provide a range of feedback opportunities to assist learners with the learning of complex skill sets, the application of the canonical knowledge of the discipline to practise, and the gauging of the attainment of occupational dispositions required to 'become' trade practitioners.

In developing assessment for learning approaches, learning is designed to leverage off students' existing literacies and increase their academic and digital literacies.

### **Capability in developing and implementing assessments for learning**

Development of alternative and authentic multiliteracies-based assessments require critical knowledge of and application to teaching practice, and of learning and assessment processes. Gaps in learning and assessment principles may lead to assessment of a narrow range of skills and/or knowledge (Curtis, 2010; NZQA, 2011). Moving into technology-enhanced learning requires digital fluency amongst both tutors/teachers and students. Therefore, as with all work towards developing new pedagogies, both tutor/teachers and learners require support to leverage off the potentialities for enhanced learning (Chan, Fisher & Sauer, 2012).

The project encompassed two stages. The first, centred around developing and deploying new approaches to e-assessments including collation of naturally-occurring evidence and formative feedback through the use of notetaking and tracking software; e-Portfolios emphasising the collection and collation of multimedia evidence; and learning support and assessments through role-plays or simulations in virtual environments and VR platforms. The second was to distil from the projects developed across the first stage, guidelines for the development and deployment of assessments for learning or e-feedback for optimum learning. The guidelines and resources are derived from authentic vocational education practice and include templates for learning and assessment design, development, implementation and evaluation.

Although the project's primary aim was to develop guidelines for the effective implementation of e-assessments within an Aotearoa/NZ context, through the analysis of innovative e-assessment approaches, secondary goals were also formulated.

These included the following:

#### **For learners**

- Align assessment to graduate profile outcomes.
- Assist learners to attain important multiliteracies (including academic, digital, cultural literacies and self-management and problem-solving traits) to meet graduate profile outcomes and as preparation for future lifelong learning.
- Provide e-assessment activities to support and enhance learning for disengaged learners.
- Acknowledge the worldview of learners' different cultures and honour these in the design and implementation of curriculum and e-assessment practice.
- Extend the capabilities and potentialities of e-assessment beyond text-based paradigms.

#### **For tutors/teachers**

- Transition from narrow task-based to authentic and holistic teaching, learning and assessment practices.
- Test the multiliteracies-based learning approaches' alignment to graduate profile outcomes.
- Contextualise e-assessments for compatibility with vocational learning.
- Apply sound pedagogy to and evaluate innovative, leading edge e-assessment approaches exemplified by e-Portfolios, role-play and simulation in virtual environments and virtual reality platforms.
- Disseminate the guidelines through methods which will reach vocational educator and workplace training audiences.

#### **For organisations**

- Increase expertise in e-assessment to achieve better outcomes for students e.g. through real time tracking of student progress.
- Diversify delivery methods to meet the needs of a wider range of learners.
- Improve deployment of e-assessments across multiple campuses.
- Build capability for reflective practice, including through PAR, across Institutes of Technology and Polytechnics (ITPs) and other organisations.
- Identify synergies across sub-projects and organisations to ensure cross-pollination of good e-assessment for learning are implemented.



## Literature

In this project, the emphasis was on implementing alternative, innovative and emergent forms of e-assessments for learning to support vocational learners. In this section, e-assessments are defined and discussed. The various frameworks supporting the project's approaches are also presented and summarised.

### E-assessments for learning

#### **Alternative assessments of and for learning**

Firstly, the rationale for the shift to alternative assessments is presented and discussed. In particular, the move away from a norm-referenced, summative assessment (e.g. written examinations) are summarised.

Contemporary accounts on learning concur that inter-psychological learning involves all our modalities (Barsalou, 2008). Our senses and neural systems engage with lived experiences to construct individual perspectives of the world. The types of activities engaged with, structure the ways in which we remember and formulate our knowledge and skill frameworks. Situations we encounter, and work through, are the constituents of cognition. Hence, our understanding of what takes place in our world is grounded through our sensory and bodily experiences, into our cognitive networks (Barsalou, 2008; Billett, 2014).

Vaughan (2008) recommends a shift away from the theoretical emphasis on learning to what actually occurs “in practice and in specific industries and workplaces” (p. 28). Some of the less quantifiable aspects of ‘learning to become’ may be assisted by the development of various multiliteracies (The New London Group, 1996), which are now required for contemporary and future working life. The role of authentic assessments provides students with ‘deeper’ and situated learning (Lave & Wenger, 1991); development of skills which are relevant to the work they are preparing for; and increased learner motivation due to overt links between learning and application (Gulikers et al., 2008). Additionally, in line with current social developments, Broadfoot et al. (2016) argue for the need to change assessment practices to ensure education keeps pace with the need to equip citizens of the future with the skills and knowledge to cope with a rapidly changing world. Hence, there is a need to ensure assessments do not just credential discrete skill sets and knowledge, which may cease to be relevant in the near future. Instead, assessments should be better placed to assist learners in developing skills to utilise readily accessible knowledge and to problem solve, synthesise and innovate.

## **What are assessments ‘for’ or ‘as’ learning?**

In this section, the purposes and definitions of assessments for learning are presented and discussed. Hattie (2015), through a synthesis of over 800 meta-analyses on learning, found learner efficacy to be one of the most important contributing factors to learning.

“Assessment for learning is the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there” (Assessment Reform Group, 2002). Assessments for learning are also conceptualised as assessments as learning (AaL) (Dann, 2014) and integrative assessments (Crisp, 2012), which are forms of ‘formative assessment’. In essence, whereas assessments of learning (summative assessments) yield a decision on learners’ performance at a given stage in their learning; assessments for learning revolve around activities providing the learner with feedback on how their learning has progressed (Sadler, 2010). Assessment for learning is different from forms of feedback occurring through other types of assessment, in that they are embedded into teaching and learning as they occur; require learning goals to be shared with the learner; are aimed at helping the learner learn how to judge and progress their own performance and learning, through forms of self-assessment; provides feedback which allows the learner to proceed; and involves both learner and tutor/teacher reviewing and reflecting on the feedback (Assessment Reform Group, 1999).

Hence, assessments for learning provide feedback to the learner, to improve their learning as it proceeds. Assessments for learning (Sadler, 2009) assist learners to learn from the feedback (Hattie & Timperley, 2007) provided by ākonga to ākonga (peers) and kaiako to ākonga (teachers/supporters) through a tuākana/tēina (supportive mentoring) model (Apanui & Kirikiri, 2015). Information from feedback may then be used by learners to modify or improve their learning approaches, leading to better on-going learning. Another purpose for assessments for learning is to help learners learn the important aspects of judgment required for practice in all occupations (Chan, 2015). Through engagement with assessments for learning, learners begin to understand and learn how to use the ‘response genre’ and criteria for quality relevant to their discipline context and extend their learning of the ‘tacit knowledge’ aspects (Sadler, 2010). Therefore, assessments for or as learning, should shift the emphasis of ‘teaching’ towards assisting learners to make sense of feedback (Dann, 2014).

There are some disadvantages to assessments for learning. Bennett (2011) summarises several of particular relevance to assessments for learning supported by or conducted with

digital technology. Assessments for learning have had limited attention on what they propose to support. Bennett (2011) uses the term 'domain considerations' to encompass the need for concepts and measurement principles to frame the design of assessments. The learning objectives of assessments for learning are often inferred, leading to learner confusion as to the purpose of assessment for learning activities, the inexact nature of feedback, and the ways in which learners respond. There is also the need for professional support of teachers. The largest benefit of assessments for learning is to ensure there are clear and direct connections between learning outcomes, assessment for learning activities and assessments of learning.

### **What are e-assessments?**

Stowell and Lamshed (2011) offer one relevant definition of e-assessments as "the use of information technology in the design, delivery and administration of assessment activities, including the reporting, storing and transferring of assessment data" (p. 3). To date, e-assessments and on-line assessments have strong 'text' literacy biases (Gikandi, Morrow & Davis, 2011; Terrell et al., 2016). Many current approaches used in technology-enhanced learning centre around written discourse and genres exemplified by discussion forums and 'chat rooms', the review of learning activities which include multiple choice quizzes, and written feedback provided to essays, reports and 'reflective' journals. Even constructivist learning approaches often rely on the collation of predominantly text-based evidence, as exemplified by entries in blogs, wikis and e-Portfolios. Therefore, e-assessments require re-envisioning to allow the recognition and support of the multimodalities, multiliteracies and sometimes unspoken or difficult to describe aspects of VET learning.

Additionally, the ability to leverage off digital technologies, brings with it advantages and challenges (Daly et al., 2010; Terrell et al., 2016). The advantages of shifting to digital means of assessments include the facility to capture authentic learning and keep a progressive record of learning as it proceeds. Learning can be video or audio recorded providing an opportunity for immediate analysis to accelerate learning; sharing with peers or trainers for feedback; setting aside for later scrutiny and consideration to improve learning; and/or archived for collation into reflective portfolios or as evidence for records of learning.

Disadvantages include the need for learners and their teachers, trainers, employers, etc., to be sufficiently digitally fluent to work with and across a range of digital hardware, software and apps. As mobile learning opportunities become mainstream, just-in-time access to learning and feedback may also lead to the need to balance learners' expectations with the workload pressures placed on feedback providers.

## **How are e-assessments different or similar to non e-assessments?**

The potentialities of e-assessments are proposed to provide benefits for learners, teachers, assessors, regulators and industry (Stowell & Lamshed, 2011). Many of the benefits listed pertain to the administration and logistical processes for summative e-assessments. Benefits relevant to formative e-assessments for learning include:

- provision of timely feedback to students via connections to teachers/trainers or peers through automatic marking systems or social media;
- linking of assessments to other 'on-line' course systems including learning management systems (LMSs), 'virtual' classrooms and mobile devices;
- collection of evidence on skills and knowledge through methods including e-portfolios, gaming, simulations, role-plays and virtual worlds;
- storage of evidence (for example, 'cloud' storage) which allows for ease of access for learners, teachers and administrators; enhanced opportunities for 'interactive' learning activities to engage learners; and production of learner content (e.g. via blogs, wikis, digital stories, etc.) is enabled;
- remote access to assessment materials providing enhanced capability for moderation of assessments for learning by stakeholders external to the institution or organisation (Stowell & Lamshed, 2011).

Many of these potentialities relate to the ability to share digital artefacts across devices, time and space.

Aspects of e-assessments of learning which have had considerable attention have focused on plagiarism, the authenticity of the learner and data security during assessment events (Gikandi, Morrow & Davis, 2011). E-assessments for learning are less likely to encounter similar challenges. When carefully designed, e-assessments for learning gather evidence of learning across time, allowing for relationships to be built between learner and teacher/assessor, obviating some of the challenges of learner authenticity.

### Convergence of e-assessments for learning and technology-enhanced learning

The feasibility of using technology to capture learning as it takes place through the use of audio, video and/or screen recordings has increased due to the ubiquity of mobile devices and their improved capabilities, an accompanying increase in access and decreased costs of mobile devices, supported by wider access to Wifi and high speed broadband. These technological advances have increased the ability to leverage off 'just-in-time' feedback from teachers through assessment for learning processes.

The availability of digital platforms to record and archive learning is now therefore achievable at lower costs, enabling greater capacity to undertake innovations through the deployment of e-assessments for learning.

Additionally, two thirds of people in the world now own a mobile digital device (We are Social, 2017). In 2013, there were more mobile phones than people in NZ, leading to a 111.1% mobile phone ownership statistic (Wikipedia, 2017). Smartphone ownership, especially amongst people aged between 18 to 34, is now over 90% in 'developed' countries like Canada, Germany, Spain, the United Kingdom and the United States of America (Poushter, 2016). In general, young people keep their mobile devices with them in easy reach, unless workplace restrictions apply. The current cost of mobile data is now considered to be affordable. Young people, especially, prioritise ownership of mobile devices, and the ability to pay the ongoing costs, due to their engagement with social media (Frielick & Sciascia, 2016). Workplaces are also now more willing to allow workers to use mobile devices during work for purposes of learning, assessments or credentialing (Dimond et al., 2016). Hence, accessibility to digital tools is now less of a challenge when compared to projects a decade ago. For example, in the early 2000s and into the mid-2000s, difficulties encountered by apprentice bakers collecting photos of their work and short videos of their work processes, included the issues of access to suitable mobile devices and the costs associated with upload and download of mobile data (Chan, 2011). Currently, these issues are mostly surmounted, and replaced by issues of privacy, learner and teacher digital fluency, and the importance of connecting teaching and learning goals to technology enhancers.

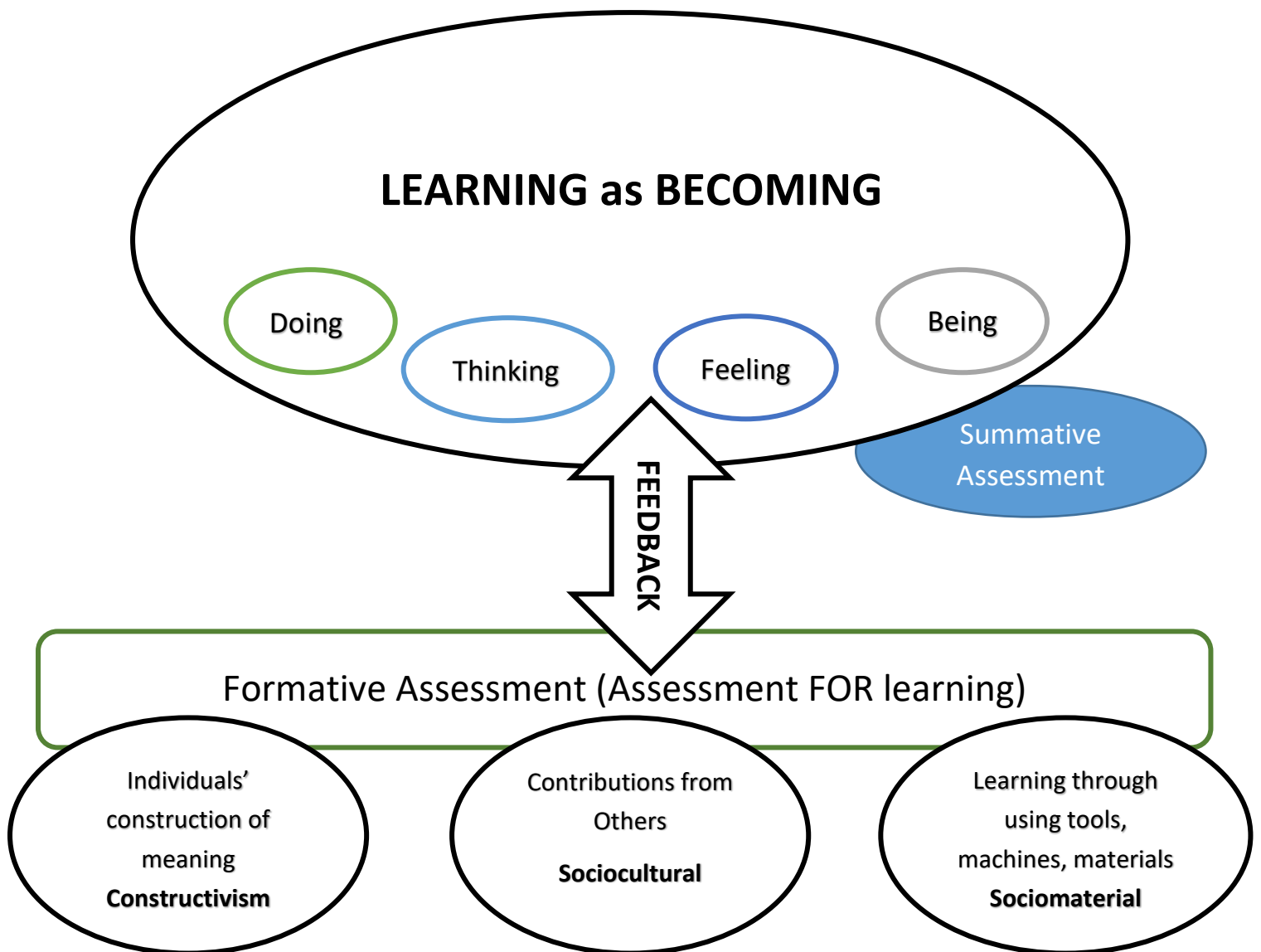
Deploying e-assessments for learning to support occupational identity formation Chateris et al. (2016) builds on the work of Pryor and Crossouard (2010) to advocate for the role and purpose of assessment for learning to include the development of learners' identities. Both these papers present critiques of contemporary education's assessment for learning as largely focused on the 'performative', while neglecting aspects of invoking learner identities. Both papers propose the move towards a conceptualisation of assessment for learning as supporting 'existential' learning (i.e. learning for living and life). In particular, to allow assessments for learning to assist the movement of learners from evidencing the concrete and procedural, towards allowing learners to record the reflective, discursive and existential. Hence, assessments for learning require design and deployment to allow for recording learners' progression from being able to complete tasks, to collating evidence on learners' reflections on how to carry out processes and to improve their work,

to finally supporting learners to ask what their role is in the process, and the contribution of their forming identities as they proceed. Hence, learning can be re-conceptualised to be not just the obtaining of credentials, but assisting people to 'learn to become' (Hodkinson, Biesta & James, 2008).

Learning as becoming leads to more than the attainment of a series of competencies, a corpus of knowledge and the dispositions exemplifying forms of work. Becoming implies practitioners' ability to embody and personify, holistically and synergistically, the presence of their being. Educational technology may be used to assist learners to attain some of the perceptually grounded or embodied cognition required in some fields of study (Black, 2010). Students' learning and understanding have been improved through the use of interactive graphic computer simulations, which include movement and animation; interactive graphic simulations requiring learners to act on feedback; the creation of video games; and programming of robots (Black, 2010).

Connecting e-assessments for learning as becoming to graduate profile outcomes  
The changeover of NZ qualifications towards graduate profile outcomes has provided unique opportunities to shift learning from 'passing tests' or 'ticking off competencies' towards educational processes leading to holistic outcomes (Chan, 2016). Beginning in 2012, the current on-going review of new NZ certificates and diplomas require the re-development of all programmes of study. In NZ, programmes of study are the documents detailing how qualifications are 'delivered' to ensure students are provided with the learning to meet qualifications' graduate profile outcomes. The graduate profiles in NZ certificates and diplomas detail the performance of the graduate in relation to the designated level of the qualification and specify the key capabilities, including high-level skills, knowledge and attributes, to be attained through undertaking and completing a programme of study. NZ certificate or diploma programmes may be completed through full-time study, workplace learning or a combination of 'formal' institutionalised learning and workplace learning (NZQA, 2018). Therefore, the prospect of transforming learning and assessment approaches, as framed by perspectives of learning as becoming, has been made available (Hodkinson, Biesta & James, 2008). Learning as becoming implies students learn the skills, knowledge and attributes that assist them to 'become' or to progress to programmes with higher levels of learning, leading to employment. Vocational learning encompasses a wide range of multiliteracies (The New London Group, 1996) involving practitioners' multimodal engagement with aspects of the

sociomaterial (Fenwick, Edwards & Sawchuk, 2011) epitomising various occupations and disciplines. Hence, to optimise students' sense of becoming, an emphasis is placed on the provision of programmes of study through authentic learning environments and activities. In so doing, students learn the ways of doing, thinking, feeling and being, in turn assisting them to integrate into occupational ethos and culture (Chan, 2013). Diagram 2 brings together the project's conceptualisation of 'learning as becoming', the role of assessments for learning in assisting 'learning as becoming' and how these connect to the graduate profile outcomes of NZ qualifications.



*Diagram 2: Connecting graduate profiles to the concept of learning as becoming*

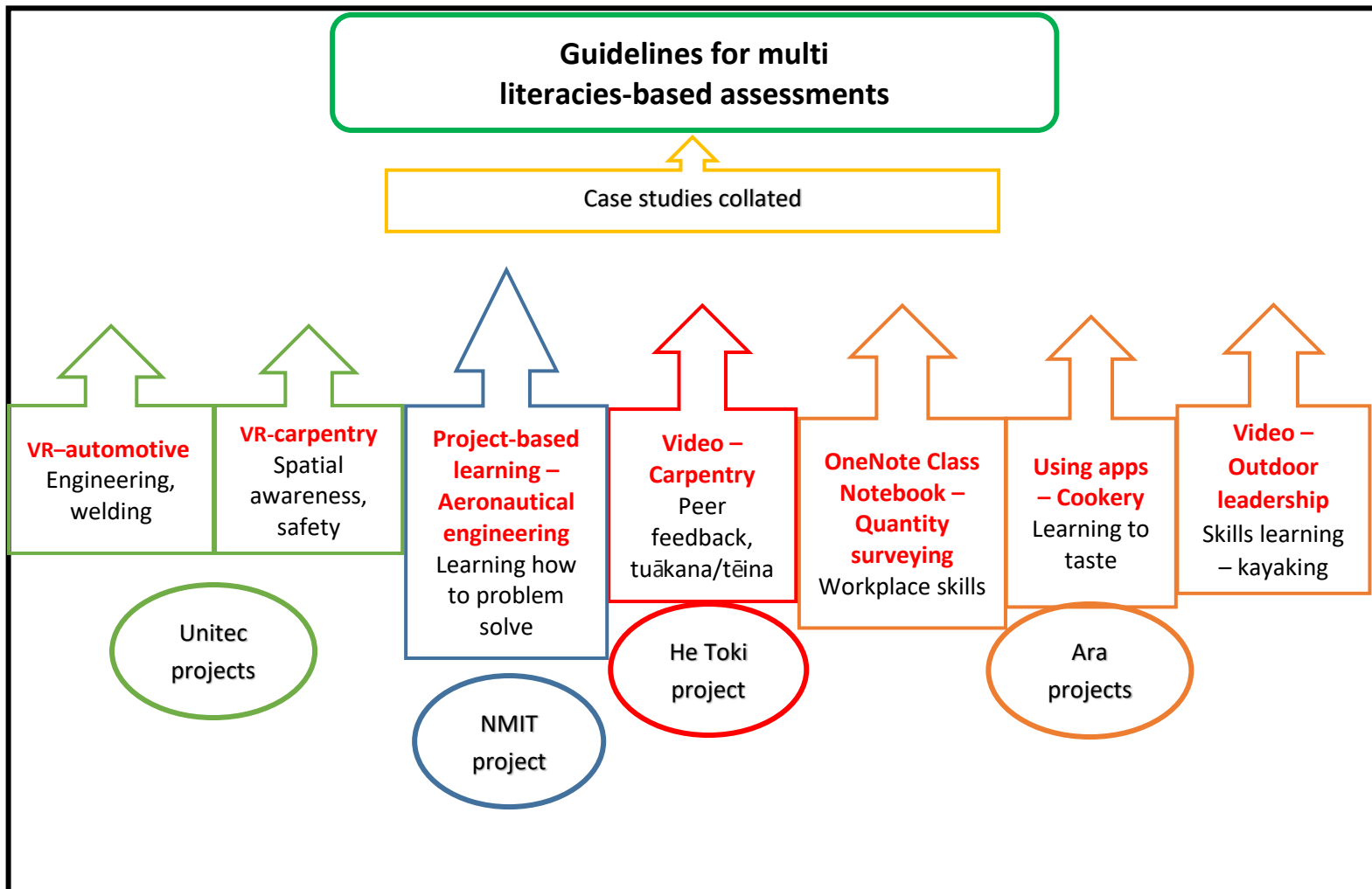


## Research method

The project's research methodology is informed by constructive-interpretative paradigms. There are two distinct parts to the project.

- 1) The Participative Action Research (PAR) approach is utilised through each sub-project to refine innovative e-assessment processes. Through several iterations of PAR, various challenges deploying each form of e-assessment are identified and resolved.
- 2) Case study methodology is then used to collate the various strategies used by the sub-projects and to synthesise the guidelines for optimal deployment of e-assessments.

In diagram 3, the seven sub-projects and how they fit into the larger study is visualised. Details of each project are provided in the appendices and summaries are presented in the findings section of this report.



*Diagram 3: Sub-projects objectives as proposed at the beginning of the project*

## PAR through the sub-projects

### **The PAR processes**

PAR involved all of the sub-project team members (tutors/teachers, team leaders and lead researcher) and their students. The cycles of PAR included planning the questions for each step in the research process, carrying out the investigation through observing, evaluating, reflecting and making appropriate adjustments, before moving on to the next cycle (Heron & Reason, 2001; Wadsworth, 2001). Each sub-project went through several iterative cycles of PAR to understand the various supports and barriers encountered by tutors/teachers and students as innovative e-assessments were deployed. Each sub-project investigated the efficacy of these innovative approaches, and analysed the data attained through student and tutor evaluations (via questionnaires or focus groups) and class observations, formulated findings, developed and articulated their understandings through virtual conferences and various conference presentations, and reported their findings (see the appendices for reports from each of the sub-projects).

At the very beginning, each sub-project's 'research question' and objective was identified. Assistance and overview by the lead researcher ensured coherence across the sub-projects. The initial 'research question' formed the anchor for each iteration of the PAR cycle. The initial 'research question' also informed selection of the types and methods of data collection and analysis within each sub-project. To assist further capability building through the project, all PAR results, and the case studies built from the sub-projects' PAR, were shared through peer review processes.

### *Data collection*

Data collected and collated included programme documents, course and lesson plans, resources used to support learning activities, teachers' reflective journals, learning analytics (Dawson & Siemens, 2014), student demographical information including literacy and numeracy survey pre- and post-programme scores where relevant, students' e-assessments, student evaluations through surveys and/or focus groups at the beginning and end of the programme, and industry/stakeholder perspectives, where relevant.

### *PAR data analysis*

The data collected as sub-projects proceeded was analysed at an identified point established through the planning stage of each PAR cycle. For example, the end of one

cycle may be an analysis point in the course. The results from the reflective process of evaluating the data from tutors'/teachers' reflections, student focus groups and other e-assessment artefacts led on to the next 'research question' and began the next PAR cycle.

Sub-projects cycled through two to four PAR cycles across the life of the overall project. Each cycle in turn provided actions for advancing each sub-project's goals.

### **Comparative case studies to synthesise guidelines**

#### *Constructing case studies from each sub-project*

Data produced by each sub-project's PAR cycles was collated into case studies. The case studies included PAR plans and evidence and results from the reflective and evaluative PAR cycles. Learners' demographic information and programme documents were also used to construct the cases. Each case formed a narrative of each sub-project's journey as PAR proceeded. Included were each sub-project's 'research question', the various options used to find answers to the question, the e-assessments developed, e-assessment deployment, the challenges, solutions, and tutor/teacher and learner experiences/evaluations, etc.

#### *Comparative analysis of case studies*

Case studies have been used to build models of higher education e-assessments (Daly, Pachler, Mor & Mellar, 2010). In this project, the case study analysis technique known as process tracing was used to establish the causal patterns contributing to outcomes in each case (Eisenhardt, 2002).

In process tracing, an identified theme or thread, detected through classification of commonalities and discrepancies between cases, is followed to determine the contribution of factors impinging on the theme or thread. For example, it was found that the quality of e-assessment evidence was a challenge for several of the sub-projects. This theme is traced backwards and forwards through the PAR data trail to find the causes and remedies used to meet the challenge. These causes and remedies/solutions, formed the foundation of the guideline development.

### **Building the guidelines**

Synthesis of the themes arising from the process tracing analysis method were used to construct models and guidelines. For example, the data may indicate that the causes for inconsistent quality of assessment evidence is a lack of clarity from students around assessment instructions. In the case studies, the solutions used were contextualised to each team's collective capability and organisational processes.

Each of the contextualised solutions were then analysed to extract a generic guideline. A model for supporting the development and deployment of e-assessment relevant to the Aotearoa/NZ vocational education sector was then derived.



Ethical approval for the project was obtained through the Ara Institute of Canterbury Academic Research Ethics committee. Each of the sub-projects also undertook to attain individual ethics approval from their own Institution's research ethics committees, to ensure research participants (tutors/teachers, students, workers) were informed and consent obtained. Where possible, sub-project team leaders, who were not teaching the students involved in the study, carried out student focus groups. Tutors/teachers did not carry out focus groups meetings with their own students. All other artefacts collected during the sub-project were obtained with participant permission. Confidentiality of all learner participants was covered by ensuring only pseudonyms were used in any reporting of findings, including audio and video reports. Data collected was stored in lockable filing cabinets, or similar, and digital evidence was stored on password protected computers. The Google+ project working site, set up to share research readings, is a private site accessible only to the project team.




## Findings



### Sub-project details

Table 1 provides an overview of the seven sub-projects. The original sub-project objectives were derived at the beginning of the project based on interim discussions and literature reviews of the topic. As PAR cycles proceeded, the original objectives shifted to allow for the realities of teaching and learning practice. Summaries of each sub-project follow in Table 1 and the details of each sub-project can be found in the appendices.

*Table 1: Overview of the sub-projects*

Sub-project	Researcher	Original objective (n= participants)	Where it fits in the course?	Tools trialled	PAR cycle	Challenges	Solutions	Tutor experiences	Learner experiences
 KAYAK SKILLS	<b>Steve Chapman</b>	Improve kayak roll (students – L5 = 34; L6 = 9; L7 = as tutors)	Used to support practical learning sessions	Video on tablet	2	Complex skills; Student engagement	Using video to enhance feedback between students and students and tutor	Logistical issues with digital devices outdoors	Learners' accelerated learning and feedback skills
 LEARNING AT WORK (WIL)	<b>Keith Power</b>	Monitor students on WIL (2017 = 15; 2018 = 15)	Tracking students while they are on WIL	OneNote Class Notebook	2	Students' digital skills	Using OneNote to keep track of and support students	Student engagement requires clear reasons from	Students who engaged, found the process to be useful

							during WIL	tutors/teachers	
 <b>TASTING FOR CHEFS</b>	<b>Cheryl Stokes</b>	Improve tasting and reflective learning (students = 26; tutors = 2)	Across several courses to help learn a sensory skill crucial to the occupation	Mind mapping Mobile devices Note taking	3	Students' and tutors' digital skills; Academic skills to record and reflect on learning	Improving the learning and recording of sensory evaluations using apps	Digital literacy and teaching capabilities require support	Improved sense of the need to formally learn how to taste
 <b>PROBLEM BASED LEARNING</b>	<b>James Gropp</b> <b>Aaron Lyster</b>	Improve student's problem-solving skills (students = 11; tutors = 4)	Across several courses to trace students learning of problem-solving skills	OneNote Class Notebook	3, on-going	Students' digital skills; Students' emphasis on task rather than learning	Using OneNote for students to compile e-Portfolios and for tutors/teachers to follow students' progress	Shifting emphasis from completing task to learning about the process	Realisation of the importance of reflective learning
 <b>CARPENTRY PEER LEARNING</b>	<b>Kym Hamilton</b>	Enhance learning through peer feedback	Improve learning as skill development progresses	Video on GoPro	2	Students' ability to articulate using visual medium	Using video as a conversation starter	Initial reluctance of learners to engage	Improved skills learning and feedback

		(students = 6; tutors = 2)					for feedback		
 <b>CARPENTRY</b> VR	<b>Kamuka Pati</b> <b>Alan Warburton</b>	Improve safety awareness and spatial skills (students = 36; tutors = 8)	Distinct skill and disposition	VR	2, on-going	Development of an important dispositional trait	VR provided authenticity	New technology required large amounts of development time	Improved positive and pro-active attitudes to safety
 <b>WELDING</b> VR	<b>Lee Baglow</b> <b>Chris Lovegrove</b>	Accelerate learning of initial welding skills (Students = 64; tutors = 4)	Skill learning within one course	VR welding simulator	2, on-going	Complex skills; Students' and staff's digital skills; Understanding learning analytics data	VR allowed for some of the many sensory inputs of welding to be held back, allowing for better learning of basic skills	Potential pedagogy not yet explored in full	Preferred VR simulator at the beginning, but once skills were attained, 'real' welding was preferred



Apart from two tutors/teachers, all the others involved in PAR had not previously engaged in a formalised research project. The project team gathered for a two-day workshop in January 2017, to build research competency, fine tune key research questions and match these to PAR approaches.

A brief overview of each of the PAR sub-projects are presented below. The intent of the sub-project, discipline-specific background, student demographics and findings are reported. More detailed information on each sub-project is attached in the appendices.

Three sub-projects to inform the construction of the guidelines were completed at Ara Institute of Canterbury.



### Improving the learning of kayak roll using video



#### Objective:

Understand what effect multimedia could have in assisting Outdoor Education students learning to white-water kayak.

#### Background:

While there are extensive studies on using multimedia in the teaching and learning of sports (Leser, Baca, & Uhlig, 2011), we could not find any literature on the effect of multimedia on students' learning to white-water kayak. Learning to white-water kayak is often referred to as a counterintuitive process. A case study research approach was taken and data collection for the study was carried out through practical class lessons, a survey and questioning of students at the learning environment.

#### Findings:

Student learning appears to have been accelerated and success rates improved through various uses of multimedia (pre-class and post-class). Students had the opportunity to view a video of kayak roll before attempting the activity. Video of students' practice sessions were then available for review and immediate detailed feedback. This appeared to decrease the required time to gain some key skills, such as 'rolling' a kayak, as well as helping students manage and/or reduce their frustration levels at learning new motor skills.

While tutors/teachers continued to provide feedback, groups of students were also able to provide feedback to each other through pausing or running the videos. Students could also analyse each other's activities and learn from each other in a positive manner. There was increased understanding about what constituted good form in practice, allowing students to build up a visual library with supporting theory by which they could make judgements on what good practice was. Students were

then able to proceed with deliberate practice, both during and outside of timetabled class time.

While the video footage clearly provided formative feedback to students, the footage also offered opportunities to be used both as summative evidence for assessment and for moderation purposes.



## E-assessment of work integrated learning in quantity surveying



### Objective:

What essential knowledge, skills and literacies do quantity surveying students require to complete work integrated components of the New Zealand Diploma in Construction?

### Background:

In February 2017, Ara commenced delivery of work integrated learning (WIL) within the New Zealand Diploma in Construction (Quantity Surveying). As recommended through the work placement and practice-based learning literature (see Billett & Choy, 2013 for an overview), it is important to support students on WIL before they commence their placement, during the course of their work, and to facilitate reflections on WIL after they return to the programme. Therefore, the purpose of this study was to ensure that students are able to take full advantage of the industrial experience. Before commencing their placements, students were introduced to OneNote Class Notebook and received instruction on their roles and responsibilities, such as health and safety, and confidentiality of commercially sensitive information.

Students kept an e-portfolio using OneNote Class Notebook and recorded a log of the tasks carried out on placement and the number of hours worked. A staff member kept in touch with students and arranged face to face meetings via OneNote Class Notebook. Course assignments were submitted electronically and on paper to course tutors/teachers.

To gauge the effects of the support through e-assessment for learning, evaluations were conducted with students individually. A focus group discussion was also held with a group of five students from the first cohort.

### Findings:

Students thought they were well prepared for WIL by their knowledge of building construction, their skill in measuring quantities and the use of spreadsheets. Areas where they felt they lacked preparation centred around the complexity of modern construction documentation and their awareness of the various quantity surveying

roles in industry, exemplified by working within private firms, contractors, or specialist subcontractors/suppliers.

A total of 16 students were placed on WIL between July and December 2017. A second cohort of 15 students are currently still on placement, having commenced work integrated learning in January 2018. All students were very positive about their experiences on placement and considered that employers looked after them well.

The study concluded that work placements require sufficient lead in time and adequate staffing resources, and that WIL components are best incorporated into just one full year course rather than across several single semester courses. For students to submit work for assessment using OneNote Class Notebook must be a requirement of the course, rather than optional. Other findings included the need for greater familiarity with commercial contract documentation, including cloud-based construction management software and annotation of PDFs.



Developing reflective practice of Level 4 cookery students through sensory analysis of food



Objective:

What is the best practice for learners to reflect on experiential learning activities synchronously, using mobile devices?

Background:

Level 4 cookery students (n = 26) and 2 tutors/teachers were being scaffolded towards the compiling of an e-Portfolio at Level 5 of study. Level 5 tutors/teachers had found students were unprepared for the level of recording and reflection required to compile e-Portfolios. This study used a range of apps to assist students to collect evidence of their cooking, support the building of a vocabulary to help describe dishes and sensory evaluations, and build digital skills.

Findings:

All participants had a mobile device, either IOS or Android operating platforms, and were already using the camera app to take photos and/or videos of practical demonstrations. From observing lessons, it was noted most students used their smartphone to take photographs of the steps needed to produce the dish, the final plated dish and the tutor's dish, and some videoed the tutor demonstrations. The majority recorded tasting notes from memory, either later that day or close to the due date of the assessment.

Two free apps, operating on both iOS and Android, were trialled. Firstly, the students used Mindly (a mind mapping app), in a guided tutorial with activities (Denton, 2012),

to create a tasting mind map to build vocabulary of the key areas of sensory analysis – appearance, temperature, aroma and taste.

The second app, Google Keep, enabled the students and tutors/teachers to take photos and type a short critique of the dish and record anything they would do differently next time (Sadik, 2008). Google Keep features included the ability to write notes in any language, as well as allow voice recordings to be converted to text. In doing so, students could utilise functions that best work for their preferred literacy style and could be encouraged to take ownership of their learning (Cochrane, 2010).

Final feedback from students revealed they were more comfortable with Microsoft Word than Google Docs; they were initially dragging their Google Keep photos into the scrapbook template, then converting the document to Word and completing the written components. This feedback confirmed that the Google Keep app was being used, but only to record photographic evidence, not for the critique or reflection.



### Improving students' problem-solving skills by using project-based learning supported by OneNote Class Notebook



#### Objective:

Determine if problem-based learning (PBL) methodologies combined with reflective practice within an e-portfolio application would improve students' learning outcomes.

#### Background:

The Level 4 Certificate in Aeronautical Maintenance Engineering students (n = 11) needed to be more reflective problem solvers. OneNote Class Notebook was used by students to collect evidence of their projects, as they completed tasks. However, the students were often unable to articulate how they proceeded in problem finding and problem-solving (Dochy et al., 2003). This aspect has been found to be common in the teaching of critical learning (Halpern, 1999) and with problem-based learning approaches (Hmelo-Silver, 2004) (Tiruneh, Cock & Elen, 2017).

The learning trial collected by students on their OneNote Class Notebooks, allowed tutors/teachers to follow the learning journey and to support students to become more reflective about how they learned and problem-solved. In particular, an emphasis was placed on supporting students to 'learn from their mistakes' (Mason et al., 2016)

#### Findings:

An emphasis on 'what did I learn' instead of 'what did I do' was the key change made to tutor pedagogical approaches. This shift in emphasis from 'doing the task' to 'thinking about the learning goal of the task and the why and how I do the task' required staff to change the ways in which their course and workshop sessions were structured. Once staff focused on the learning process rather than aircraft

engineering work, student participation and demonstrated abilities all increased dramatically.



Supporting the learning of carpentry skills through GoPro enabled peer learning



Objective:

To support the Māori pedagogical approach of sociocultural learning.

Background:

6 students in a full-time, pre-trade programme and 2 tutors/teachers participated in using a point of view (POV) video camera (GoPro) to collect, discuss and reflect on their learning of carpentry skills. The apprentices also collected evidence of their learning and archived these for eventual inclusion into an e-portfolio. Apprentices could share their evidence with their peers and tutors/teachers.

Findings:

There was a match in the preferred modality for collecting and discussing skills learning with this cohort of learners. Stakeholders valued the attainment of digital skills by apprentices. Tutors/teachers were able to track the progress of apprentices as the apprentice journey proceeded.

Both the projects conducted at Unitec Institute of Technology included the use of Virtual Reality (VR). VR is a relatively new technology for supporting learning, requiring considered attention to VRs pedagogical contribution (Loke, 2014; Fowler, 2015).



Accelerating the learning of welding through using a VR welding simulator



Objective:

The overall questions posed by this sub-project were: “Do learners consider Virtual Welding technology beneficial to the development of practical welding skills?” and “Does the ability to receive peer feedback during VR practice sessions contribute to building a deeper understanding of the more technical aspects of welding technology?”

#### Background:

Mastering welding is reliant on practise, position of the welding torch and continuous self-assessment of weld performance (Chan & Leijten, 2012). In actual welding, the learner is challenged by restricted levels of visibility and intense heat created by the welding process (Chan & Leijten, 2012). Unitec has for several years been in possession of five virtual welding machines. It was assumed that VR could alleviate some of the environmental issues, especially at the early stages of welding skill development (e.g. saving the use of materials). The perceived advantages of VR simulators (Dalton et al., 2010; Stone et al., 2013) were tested in this sub-project.

Level 3 Automotive Engineering students (n=64) were scaffolded into the learning of the complex skill of welding by firstly learning rudimentary skills using a VR welding simulator. The use of the VR obviated some of the physical distractions (e.g. noise, smell, tight work environments), which have made it difficult for novices to learn welding. The assumption was also made that the students would already have engaged with digital games, and that the VR simulators could be introduced using gaming objectives (Galarneau, 2005). The students were all male, aged predominantly between 18-25 years old. In terms of ethnicity, the research groups were multinational, with a higher number of Pākehā.

#### Findings:

Student evaluations revealed that the use of the VR welding simulator was helpful for novice welders. The sub-project team have hypothesised that the VR welding simulator has helped reduce some of the large number of inter-connected skills required and lessened the initial 'information overload' experienced by novices. However, once the salient skills were acquired, and students became proficient with the basics of the welding process, the preference was to learn with authentic welding equipment and machines. However, learners offered several different perspectives as to the value of VR technology once they believed that they had become proficient with the physical welder. Nevertheless, there were a number of learners who expressed a significant value in returning to the VR machines to 'fine tune their skills'.



Improving carpentry students' spatial awareness skills and attitudinal approaches to workplace safety



#### Objective:

“Assist carpentry students to attain skills and attitudinal shift in health and safety within building sites” and “Can VR headsets help prepare carpentry students for real life industry experiences in relation to completing complex construction projects?”

#### Background:

The focus for this sub-project is integrating virtual environments into assessment design for health and safety with the use of VR headsets. Our carpentry graduates are exposed to hazards from day one when they enter the workforce and statistics for accidents in the construction industry are unfortunately one of the highest. Unitec has remained committed to improving graduates' awareness for health and safety in the workplace and in recent years the carpentry staff have experimented with emerging technologies such as VR. However, this project has specifically looked at extending new technologies from learning resources to assessment design.

Students from Allied Trades level three (n=14) and Carpentry (n=22) participated in this project. In total eight staff were involved, two of whom were advisors from the Teaching and Learning Centre. The standard approach has been to inform students of hazards and to show them images of workers in hazardous situations. Students would then reflect on what had to be done to manage these hazards. However, this approach has been too theoretical and artificial, often leaving students unprepared for real world environments. VR resources were developed to provide students with 'situated learning' to assist with simulation of health and safety in a workplace. The VR assessment allowed students to be fully immersed in a 360-degree building site that contained hazards. With the use of a VR headset, students were tasked with identifying hazards and discussing how these hazards could be managed.

#### Findings:

Improvement and how students perceive the importance of health and safety.

The VR approach gave two very different methodologies to compare and analyse the validity of change from traditional approaches. The data showed that 70% of participants have previously experienced VR and felt the technology was very appropriate and could be beneficial for future purposes. When students were asked to compare between traditional approaches and VR, the indication was that students learned more in the VR activity, with 100% of allied trade students supporting this notion. Furthermore, students felt it safer to enter a workplace environment after completing the VR activity, with one student commenting, *"I think this is a good way to give students a chance to work with hazards identification before entering dangerous sites"*. Although some students preferred to learn health and safety in a real workplace, the predominant thoughts from students are in favour of a virtual environment to better prepare them for work in a hazardous industry.

# Connecting sub-projects on aspects of ‘learning to become’

## Themes

The commonalities across the seven sub-projects were identified through thematic analysis of draft reports provided by each project team and sub-project reflections archived on notetaking platforms. Sub-projects also collected data using surveys, focus groups and class observations with students and tutors/teachers. These data informed the sub-projects as development and implementation of e-assessment tools and platforms proceeded through each PAR cycle. Discussion on the themes now follow, in particular, how e-assessments for learning enable technology assisted feedback (e-feedback) to improve students’ inter- and intra-psychological learning. Examples from the sub-projects are provided in each section to help illustrate the application of these themes to vocational education teaching and learning.

## E-feedback

### **Multiplicity of methods used**

E-assessments for learning can take many forms. Of importance is the matching of the learning outcomes to be achieved to the learning context and learner digital capabilities. When e-assessments for learning are used to support feedback, it is important to identify the participants of the feedback loop. Feedback may be provided between ākonga to ākonga (peers) and kaiako to ākonga (learners, learner/s and teacher, learner/s and external experts) and through learning analytics. The learning outcome desired, participants’ feedback, the learning context and the digital tools, apps and platforms have to be accounted for when designing e-assessments for learning. In so doing, some of the precepts of networked learning (Goodyear, 2005; Gros, 2017) are exemplified.



In helping chef students learn how to record their sensory evaluation of dishes, several apps were trialled. These apps were used to encourage students to move beyond brief descriptions of their dishes, towards using the vocabulary of tasting used by chefs. It took several PAR cycles to find the app which would enable the required learning outcomes and which also matched students’ digital fluency and the devices they owned.



## Multimodalities and multiliteracies

Some modalities and literacies lend themselves well to the affordances availed by digital technologies. For example, video captures practical learning activities and records movement (visual and some tactile), language and sounds (aural), and makes visible some of the sociomaterial (e.g. river conditions in kayaking; materials and tools used in carpentry).

The video of practise may then be used in various ways to ensure learning outcomes are met. As found in the 'languages of the trade' project (Parkinson et al., 2017), learning in vocational education contexts requires a large but specialised language and communication corpus and includes multimodal means for expressing knowledge, skills and attributes. Much of vocational learning centres on mimetic learning (Billett, 2014), which is anchored by deliberate practice (Ericsson, 2006) approaches. Mimesis involves the ways people learn through observation, imitation and practise, with deliberate practice requiring reflective and focused repetitive and iterative work to hone skills. These aspects of vocational learning are well matched to using technologies which are able to record knowledge, skills and attitudinal development in the form of images and sound.



Skills learning matches well with the affordances provided through the use of video. In viewing recordings of activity, many nuances and ephemeral actions can be captured. Learning moments, which may have been difficult to pinpoint in the past, are now available for discussion and reflection.

In learning how to kayak, an iPad, supported with video annotation software, was used to record students kayaking. Carpentry students recorded their work using a GoPro camera.

## Effects on learning

E-assessments for learning may be useful to promote forms of situated, authentic and sociocultural learning. Learning resources may then become multimodal, rather than text-based. The situated (Lave & Wenger, 1991) and authentic learning environments

of many vocational learning spaces (e.g. workshops) may be leveraged to good advantage when learning is captured within environments which are familiar to the learner. Additionally, multimodal learning resources or evidence encourage collaborative learning through ease of feedback channels and the building of learner self-direction (i.e. heutagogical learning (Hase & Kenyon, 2013)).



Aeronautical engineering students were able to record their workshop-based processes and to then share, discuss and reflect on their learning activities. The items collected included plans, instructions, drawings or sketches, photos, calculations and text. Individualised skills development could therefore be discussed and shared with peers and tutors/teachers. Authenticity of evidence improved the ownership of learning for these students.

### **Contribution of digital technologies to feedback processes**

The use of digital technologies (e.g. video, VR simulators) provides for timely feedback to learners. Often this feedback is synchronous, but feedback may also be recorded and used in tutor-supported asynchronous sessions. Learning analytics provided by some digital devices are another channel for feedback to learners.



Students had to learn how to analyse feedback from the VR welding simulators. The initial skills learned on the simulator were then 'transferred' into the real welding environment. VR simulators produced a range of data, which students had to learn how to interpret, understand and respond to.

### **Tutor/teacher capabilities**

In this section, the importance of tutors'/teachers' digital capabilities are detailed.

### **Connections between digital fluency and deployment of technology-enhanced learning**

As with all approaches for facilitating complex learning, e-assessments for learning requires tutors/teachers to be cognisant of the pedagogical objectives of learning sessions and be confident with the technology used to support learning. Digital fluency goes beyond the acquisition and application of digital literacies. Digital

fluency requires digital literacy. Tutors/teachers and learners with digital literacies are able to use digital technologies and know what to do. Tutors/teachers and learners with digital fluency are able to decide when, how and why a tool is used towards meeting required objectives (Miller & Barlett, 2012).



Across all the sub-projects, new technologies required building of tutor/teacher and student digital capabilities. All the tutors/teachers participating in this project, had high levels of digital fluency. Yet, there was still a need to put time into working with the new tool, software or app. This effort was not only focused on attaining competency but also to gauge pedagogical potentialities and to ensure smooth deployment within learning activities.

New technologies, exemplified by VR, notetaking platforms and learning apps, required many hours of work to gain proficiency. Confidence in using the selected digital tool to provide for e-assessment for learning was an important pre-requisite for success.

### **Must be overt emphasis on learning**

The learning outcomes to be achieved must be made overt to learners. Too often, learners become engaged in 'learning by doing' processes in vocational education. They become engrossed in 'doing' and need to be guided and scaffolded to reflect on how they are also learning.



In the sub-project at NMIT, a shift in emphasis across learning activities from 'learning how to do the process' to 'understanding how to learn about the process' was a key learning point for the teaching team. The teaching team were task-focused as workshops were run on project-based approaches. Students were expected to complete tasks and were hesitant about making mistakes or taking risks. Shifting the emphasis of workshop sessions from task completion to reflecting on the learning undertaken, provided students with the foundation for attaining important problem-solving and self-responsibility skills.

## Teacher presence and an emphasis on learning



In the NMIT project, one of the key advantages of using OneNote Class Notebook, was the access each teaching team had to each student's notebook. Course tutors/teachers could record student progress, pastoral care and learning issues in the teacher only section. These then provided a record of student progress, which was accessible across the teaching team. This allowed the teaching team to use a holistic approach across the programme and support student learning.

## Learning analytics – how to use them to inform teaching and learning

The aspect of drawing on feedback from digital sources is not new. Learners, who have grown up with gaming, have attained skills to make sense of a myriad of performance and decision-based information provided by gaming platforms. However, the capability to make the most of learning analytics, requires a structured and scaffolded approach to support students to connect analytics to their feed forward goals.



Both tutors/teachers and students required structured training to obtain the most benefit out of the VR welding simulator. An important requirement was for all tutors/teachers and students to understand the analytics provided by the simulator and to act on this information.

## Student preparation and capabilities

### **Deliberate practice / reflective learning / self-efficacy**

When deployed appropriately, e-assessments for learning encourage students to reflect on their learning; learning through deliberate practice and reflective learning assisted students to attain better self-efficacy. Deliberate practice, as defined by Ericsson (2006), is practice which is planned and with purpose. Regular practice may be repetitive and unreflective, but deliberate practice implies the setting of learning goals as practice proceeds, requiring learners to apply attentive and conscientious

processes. Reflective learning (Schön, 1983) is a cornerstone of deliberate practice. Of note is the requirement for self-efficacy in learners (Hattie, 2015).

Most importantly, it is the learner who has to make sense of learning and be able to judge where they are at with their learning and to make progressive learning goals. Intra-psychological learning, in the forms of sociocultural and sociomaterial learning, further support learners.



In the Ara project to help students learn kayak roll, video was used to assist inter- and intra-psychological learning. As reported in other work with using video to enhance practice (Chan et al., 2015), feedback opportunities for students are improved due to 'ownership' of the activities recorded on video. Of importance, is the need to help students attain the skills to judge the practice of themselves and others (e.g. by comparing their practice to an exemplar); to be enabled to cycle through the feedback loop – Am I on track? How did I go? What do I need to do to improve for the next practice run? – and to attain the communication and attitudinal skills to provide, receive and respond to feedback.

### **Using video to improve feedback and nurture relationships**

One aspect of using video is the enhancement and nurturing of learning capability and relationship-building between students, tutors/teachers and other learner supports. In particular, the ākonga to ākonga (peers) and kaiako to ākonga (teachers/supporters) through a tuākana/tēina (supportive mentoring) model (Apanui & Kirikiri, 2015), can be supported beyond current time and space.



Apprentice carpenters in the He Toki programme used GoPro cameras to record POV work activities. These videos then became the focus of discussions on skills learning between peers and tutors/teachers. As with the kayaking sub-project, videos formed the foundation for learning discussions to be initiated and students' reflective learning to be supported, enhanced and advanced.

### **Digital literacy**

Learning through e-assessments for learning, requires students to invest effort into learning new ways of doing and acquiring new digital skills. Students are often

competent with the core functionality of their own devices and operating systems; however, technology-based learning activities often require digital fluency with Learning Management and institutional information systems, which are unfamiliar. Therefore, it is important to ensure students are provided with sufficient support and scaffolded learning to maximise the affordances of technology-enhanced learning.



Construction management and quantity surveying students are generally digitally literate and fluent with Windows-based software. However, many had not used OneNote and required structured support to ensure capability before OneNote Class Notebook was used to support WIL.

### **Mobile device ownership**

There is a need to ensure that the bring your own devices (BYOD) approach is equitable. Various operating systems (e.g. Android, iOS, Windows) bring with them diverse advantages and accompanying challenges. Student digital capability with their own devices is a key to ensuring technology-supported learning activities work.



Working across multiple mobile devices and operating systems remains an ongoing challenge with BYOD. In the main, the Ara cookery students owned mobile phones rather than laptops and tablets. Most mobile phones were on the Android OS. Equivalent apps and tools for other systems required investigation to ensure the small number of students who used iOS would not be disadvantaged. Development of e-assessment for learning reliant on BYOD requires tutors/teachers to be conversant with multiple operating systems. Access to devices covering the range of possible operating systems students will use is therefore a pre-requisite.

How best can e-assessments for learning or e-feedback for learning be deployed to support graduate profile attainment/occupational identity formation?

In this section, we discuss the main affordances of technology supporting the implementation of e-assessment for learning approaches, as they pertain to vocational education and its role to develop occupational identity. The focus here is to examine the contribution of e-assessments for learning towards learning and attaining vocational and occupational roles. In particular, the role of digitally supported feedback processes, or e-feedback, in enhancing learning across a range of vocational learning contexts. In each of the following sections, concepts relevant to each theme are introduced. Examples are provided from the sub-projects of how the theme is manifested. Then a discussion is undertaken to further understand this theme with relevance to the concept of e-feedback for learning and its contribution to supporting the processes of 'learning to become'.



Diagram 4: The contribution of e-feedback to learning to 'become'

## Meeting learners' needs

As prefaced at the beginning of this report, learning in the VET sector includes authentic learning encompassing many non-traditional learning approaches.

### *Supporting multiliteracies*

Through human history, mimetic learning through oral and apprenticeship traditions have been the means with which skills, knowledge and attributes have been learned (Billett, 2014). The industrial revolution increased access to education for human populations, shifting learning from being situated and authentic into educational institutions reliant on text-based literacies to underpin learning. In the last half century, visual and audio and then digital technologies provided the means to bring situatedness and authenticity back into learning through the use of photos, audio recordings, films and videos. Presently, digital tools are able to record activities as practised. The multiliteracies, which include the range of diverse modes of communication and media (The New London Group, 1996) inherent in all human activities, are now required to become part of everyone's repertoire of literacies.

New media literacies (Jenkins, 2006) include the ability to learn through 'play', performance and simulation; 'multi-task' across a diverse range of tasks; use appropriate judgment to evaluate sources of information; navigate and follow narratives across multiple modalities; and work cooperatively with others through networking and negotiation to attain the distributed cognition and collective intelligence opportunities now available. In turn, the nature and objectives of assessments have to also shift towards encompassing aspects of multiliteracies (Kalantzis, Cope & Harvey, 2003) with technologies enabling forms of assessment, which in the past, have been difficult to operationalise (Kimber & Wyatt-Smith, 2016).

The objectives of two of the sub-projects provide good examples. In particular, to improve the learning of skills or attributes, which are assumed to be required and which are not always made visible.



The practice of health and safety protocols and processes is an important requirement in many industries. One important consideration is that attitudinal approaches to health and safety are as important as knowledge (Christian et al., 2009). Immersion into a VR environment provides opportunities for learners to engage with authentic and situated learning. Engagement with the realistic VR environment assists



learners to think more deeply about their role in organisational health and safety practice.



The skill of tasting food is not visible in the NZ cookery qualifications' graduate profiles and students are assumed to have learned how to taste and describe their sensory experiences. However, cookery students need to be taught how to judge dishes and learn the language and workplace culture for sensory evaluation of food (Spence, 2017). The process requires learning design to ensure learning occurs.

### *Immediacy of feedback*

Another important advantage proffered by digital technologies is the immediacy of feedback (Moscrop & Beaumont, 2016) to support the inter-psychological processes of learning. Mobile devices are equipped with hardware to record and play back audio, video and text. Digital technologies support learners' access to expertise via virtual asynchronous and synchronous means. Learners are able to retrieve multimedia 'text books', video resources and simulations to complete aspects of mimetic learning (learning through observation, imitation and practise). Access to expertise through digital media allows learners to extend their range of learning; examples include access to specialised knowledge or processes or expert performances. Timely feedback from peers who may be situated across different time or space is now attainable and cost effective. Digital tools also allow for the extension of the range of possible tools, materials and products, which are difficult to attain, or too expensive, or logistically complex, to offer as authentic experiences or through simulations. The next section provides examples relevant to VET practice.

An example is the use of notetaking tools to help tutors/teachers keep track synchronously and asynchronously with learners on WIL placements.

## Mimetic learning, deliberate practice and reflective learning

Individuals' intra-psychological learning includes processes of mimetic learning (Billett, 2014), deliberate practice (Ericsson, 2006) and learner reflection (Schön, 1983). These processes assist individuals to make meaning through engagement with work processes, and to learn vocational knowledge, skills and attributes. Technology-enhanced learning offers opportunities to gather feedback on learning through various means. In particular, e-feedback may be attained through learning activity cycles (Moscrop & Beaumont, 2016). Timely e-feedback may then be offered prior to or in preparation for practice, during practice or in-task guidance, and post activity feedback on the meeting of learning objectives (feed up), the quality of performance (feedback), and plans to progress with learning (feed forward). Each of these cycles may be mediated by technology.

Feedback was crucial in all the sub-projects, but especially important when novices were undertaking skills learning, as it is often time-consuming and difficult to 'unlearn' poor technique.



Using video to improve practice was obtained asynchronously, after students had completed a kayak run. However, this feedback was provided whilst the activity was still fresh in the students' minds and the video, taken of the run, was useful as a memory prompter, discussion starter, foundation for reflective learning and feedback anchor.



Learning welding with the VR simulator provided students with synchronous feedback as they performed a weld. This information provided learning analytics, which were not available through real practice, as the statistics produced in real practice are not easily recorded. Students were able to complete multiple practice sessions to hone technique on the VR simulator. Each session providing feed forward to enhance deliberate practice and prepare the student for eventual engagement with 'real' welding.

### *Using video to support mimetic learning and deliberate practice*

Firstly, there is the opportunity to review recordings of practice. These recordings may form the foundation and be models for novice practice in the form of videos of

'expert' practice or through VR experiences (Fowler, 2015). Novice learners require support as they may find difficulty in identifying the parts of activities which may be novel and/or complex. The sports psychology literature abounds with examples of how learning through observation can be utilised to prepare athletes to attain or improve motor skills (see Moran et al., 2012, for example). These principles may be readily applied to the use of recordings to assist with skills learning.

Secondly, recordings may be annotated with text or drawings, either by the learner, their peers, or by others who are more practiced. Used appropriately, these annotations draw learners' attention to the specialised nuances of occupational practice unfamiliar to novices. The key here is for those with more experience to be enabled to articulate what is often to them 'common sense'. A reciprocal learning opportunity is availed when the sharing of annotated recordings proceeds constructively (see Chan et al., 2014 for examples in using video to assist with the learning of the skills and dispositions required to become hotel front office staff or nurses).

Another use is to encourage learners to record their learning reflections on viewing video recordings of their practice. In so doing, learners use the language of the trade (McLaughlin, 2016; Parkinson et al., 2017), allowing for new trades vocabulary to be applied, repeated and anchored into usage in the appropriate context. Learners are also able to construct narratives of their learning (Alterio & Woodhouse, 2011) using multimedia. These digital stories may again be utilised in the various ways detailed above in this section and form the basis for reflective learning or be used to collate learner generated resources (e.g. interactive workbooks (Chan, Fisher & Sauer, 2012)).

### **The role of learning analytics**

In the main, collection of data on learners' engagement within digital learning environments have been utilised by educators and administrators (Campbell, Deblis & Oblinger, 2007). These learning analytics are more often used to gauge aspects of learners' selection of learning resources, 'time on task', number of repetitions required to attain competency, etc.. The principles of assessments for learning are to ensure the learner benefits from the information provided to action current and future learning. However, when compared to the use of learning analytics by educators and institutions, the use of learning analytics by learners is relatively new and limited (Dawson & Siemens, 2014).

There has been on-going work in the last decade on deploying learning analytics to learners to assist with monitoring learning progress (Syed, 2016). Therefore, there is much work possible in leveraging the deployment of learning analytics as a form of e-feedback to assist learners. Challenges include the inherently large amounts of information gathered via digital means, which might make the data difficult to access and understand; ethical issues around access to data by learners, possibly their peers and employers, and others; and the need to connect learning analytics to learning objectives (Dawson & Siemens, 2014).



The need for learners to make sense of feedback from a digital interface was explored through the introduction of VR welding simulators. In the main, students appreciated the opportunity to attain basic welding skills. Basic welding tool positioning and body movements could be practised before students embarked on 'real' welding.

Self-efficacy, aspects of learner 'becoming' and the learner as co-creator of knowledge

Taken as a whole, the design of where, when and how to deploy e-assessments for learning is required. In particular, the pedagogical purposes of e-assessments for learning need to be considered. Technology is one useful tool to assist the learner's journey as they progress through the voyage of 'learning to become'. Examples detailed in the above sections, may all be deployed towards helping learners record, collate, reflect on and profile their learning journey. The important aspect in this form of pedagogy is to ensure learners understand the learning objective is not just about learning discreet skills, knowledge and attributes, but about attaining a form of being, congruent with their changing identity, as they 'learn to become'.



In the sub-project supporting cookery students to learn, record and reflect on the learning of food evaluation, students learned and practised a key skill of their trade.

## Focusing on Learning

### *Collaborative learning*

As prefaced above, digital technologies enable communicative channels to open between learners and more experienced others. These include the opportunities to share and learn from peers; teachers, assessors, trainers and others with more expertise; and source expertise beyond learners' own context as with a wide range of learning materials now available on-line. It is now possible to apply the philosophies underpinning networked learning (Goodyear, 2005) with its emphasis on the connection between people to enable learning and is a 21<sup>st</sup> century enhancement of the precepts of sociocultural learning (learning from others).



Peer learning was a major objective in the sub-project using GoPro cameras to record skills learning. Discussion of the recorded videos augmented the learning of carpentry skills. Communication and team work skills were also practised and improved as students provided peer feedback and support to each other.

### *Multimodal – authentic, situated and holistic*

Although digital educational resources are still largely text biased, the availability of digital educational resources in the form of videos and pictures are now common. The accompanying improvement in bandwidth, to allow for smooth and rapid download of video, has provided increased opportunities for accessing multimedia on mobile devices. Enhanced authenticity of multimedia includes augmented and VR, providing immersive multimodal sensory experiences (Fowler, 2015).

Hence, it is now feasible for 'just-in-time' references, for learning complex skills, in the form of instructional videos. It is also now possible to represent key multimodalities (visual, aural, spatial) encompassing work processes. As prefaced in the section above on mimetic learning, deliberate practice and reflective learning, technology-enhanced learning provides affordances for the collection, archival and sharing of multimodal processes (Selander, 2016). Learners are able to access resources to support their learning, in an authentic form. Rather than reading a list of instructions, skilled processes are viewed as performances. Video, simulations and VR experiences provide situated instances of practice (Lave & Wenger, 1991), including

not only the skilled movements in carrying out a task or process, but they also allow learners to attain a better sense of various sociomaterial aspects. These could include the sound or noise generated while working on a task or, if the 'demonstrator' also articulates the process as the video is recorded, may include reference to some of the nuances of the process.



Practical skills learning in challenging environments, exemplified by kayaking through river rapids, represent teaching environments whereby feedback on technique and performance may be delayed or absent, as the tutor is unable to observe and provide feedback on all learning activities. Using video, collected by other students as individuals negotiate the river, provides recordings of practice for just-in-time feedback, either from peers or tutors/teachers. Instead of waiting until the end of each day, feedback can be provided after each run. Therefore, deliberate practice is accelerated through better and more timely access to feedback.



The use of simulators is not new. However, in learning welding, VR simulators are put to good use to help novices gain confidence before they tackle the actual practice of welding. Novices are able to hone important physical skills before exposure to extra challenges, such as heat, sparks, smell and noise, presented by actual welding practice.

### **Supporting teaching**

To maximise student learning, technology-supported teaching requires extensive and focused learning design (Goodyear, 2005). The intention of learning must be at the forefront of any introduction of technology, and e-assessments are no exception. The advantages detailed in the above sections focus primarily on learning but also provide examples of inherent affordances for teaching practice. Firstly, it is possible to extend teacher presence beyond the physical into the virtual.



Using OneNote Class Notebook allowed tutors/teachers to track students who were assigned to industry organisations for WIL. Tutors could support students with the project they were undertaking in the workplace, both synchronously and asynchronously.

Secondly, it is important to match learner profile needs to the ways most suited in terms of how they learn. Also, connections must be made between the learning outcome to be achieved, the most appropriate means of encapsulating the learning, and the learners' initial digital tools and fluency. Individualised or differentiated learning is possible as resources can be dispersed and availed through different channels, with learner access premised on scaffolding learners through various learning activities.



An example is the project at NMIT, whereby students' work was available across the teaching team. The access to student work, archived in the form of photos and written descriptions and reflections, provided the teaching team with the ability to consolidate skills teaching across the programme. Students who were able to progress more quickly through projects could be provided with extension activities, and students requiring support could be identified quickly and thus supported.

Thirdly, the opportunities to utilise learning analytics and administration (Dawson & Siemens, 2014), also provides opportunities to improve the structure or composition of learning activities, adjust the type and volume of supporting resources, increase student engagement and individualise learning instruction. Some of these opportunities for learner support may be 'automated', allowing teachers to target their instruction and maximise learner support. Examples of automation include the marking of formative quizzes and feedback from simulators and VR experiences.



The VR welding simulator provides a contemporary example of using an appropriate tool to introduce novices to complex skills. Welding is a difficult skill to learn due to the many sensory and cognitive messages novices have to deal with. Additionally, welders' physical senses are impeded by safety precautions and the need to use protective equipment (e.g. thick aprons, gloves and helmets). The VR environment provides a safe but close to authentic experience and assists in enculturating novices to the challenges of welding.



## Guidelines

The following guidelines are collated from the main themes generated through the collation of data derived from the development and implementation of innovative approaches to e-assessments for learning.

The guidelines are organised on curriculum development principles, which imply the selection and development of curriculum through learning design, deployment of learning interventions using technology, implementation of the support stage as learning progresses, and an evaluative stage that reviews the deployment and implementation and ensures the next iteration meets learning needs.

### **Selection and Development**

- 1) Align graduate profile and learning outcomes to assessments for learning
- 2) Explore and identify the difficult to articulate, undescribed learning outcomes required by learners to 'become'
- 3) Match e-tool(s) to learning outcome(s), with emphasis on enabling the 'hidden' multiliteracies and modalities of learning

### **Deployment**

- 1) Ensure teaching team capability
- 2) Prepare the learner
- 3) Make learning overt
- 4) Leverage off learning analytics, for both teachers and learners

### **Implementation**

- 1) Review after each iteration
- 2) Scaffold learner capability to use e-feedback so that it becomes personalised to their own learning

### **Evaluation**

- 1) Re-evaluate holistically the learning goals, the e-tool(s) and the resulting learning
- 2) Keep up with the play on e-tools and their capabilities to support e-feedback

Each of the above guidelines are discussed briefly below.

## Selection

### **Align graduate profile and learning outcomes to assessments for learning**

Principles of constructive alignment (Biggs, 1996) require a clear connection between graduate profile outcomes, course learning outcomes, learning activities and assessments. Assessments for learning become useful in assisting with students 'learning to become' when graduate profile outcomes reflect the occupational identity outcomes of a qualification, and constructive alignment occurs (Chan, 2016).

### **Explore and identify the difficult to articulate, undescribed learning outcomes required by learners to 'become'**

Well-designed learning activities, including assessments for learning, may be usefully deployed to assist with supporting learners to attain the range of skills, knowledge and dispositions required to meet the graduate profile of a qualification. Some learning activities may also be able to leverage off the affordances of digital technologies (e.g. e-tools) to support feedback through assessments for learning. In particular, to focus on the difficult to learn and hard to describe skills, knowledge and dispositions of vocational learning.

### **Match e-tool(s) to learning outcome(s), with emphasis on enabling the 'hidden' multiliteracies and modalities of learning**

The affordances availed by e-tools allows for some of the multiliteracies and modalities, characterising vocational education, to be accessed and supported. Again, the key is to match the potential of the e-tool to the pedagogical approach and learning intent.

## Deployment

### **Ensure teaching team capability**

The success of e-assessment deployment requires digital fluency with the selected e-tools. Tutor or teacher confidence in using e-tools is therefore a pre-requisite before they are deployed to support assessments for learning. Some innovative or new e-tools may require a large component of time to attain digital fluency. BYOD-based assessments for learning need an added requirement for the teaching team to

be comfortable with the basics of multiple operating systems. Building capability will therefore require planning and resourcing prior to introduction.

### **Prepare the learner**

Learners, in turn, must also be supported to attain digital fluency with e-tools to support their learning. Although the majority of the current student cohort may be digitally literate, recent studies on introducing technology-enhanced learning into vocational education settings (Chan, 2011; Chan et al., 2012; Chan et al., 2015) have revealed students' digital literacy to be targeted selectively towards their social and leisure needs. Therefore, students require planned and structured scaffolding on how to maximise the selected e-tool for assessments for learning.

### **Make learning overt**

Just as many vocational skills and dispositions may be difficult to describe, the learning occurring through planned learning activities and/or assessments for learning, may not be obvious to learners. A key to ensuring the effectiveness of assessments for learning is to ensure the learning outcomes are understood by learners (Bennett, 2011). Therefore, it is always important to explain to learners the reasons for and the learning outcomes of learning activities and assessments for learning. The provision of feedback between peers also requires support (Chan & Leijten, 2012), with the need to provide students with the skills to offer feedback to others.

### **Leverage off learning analytics, for teachers and learners**

Learning analytics are often gathered through e-tools (e.g. devices, apps, learning management systems, etc.). Not all the data from learning analytics will be useful for the purposes of helping learners and their tutors/teachers understand learning. Therefore, it is important to identify types of useful data and to make the relevant data available to teachers and learners. To leverage off the potential of these learning analytics, teachers will require guidance to understand how these may inform the learning or feedback process. Additionally, structured sessions are recommended to assist students to understand and action the feedback elements obtained through learning analytics.

## Implementation

### **Review after each iteration**

The use of e-assessments for learning requires continual review through each iteration. E-assessments should be matched to learning outcomes, student profiles and industry expectations. As learner cohorts refresh through each term, semester or year, suitability and availability of e-tools change and industry and future work requirements shift. It is therefore important to ensure e-assessments for learning continue to meet their objectives.

### **Scaffold learner capability to use e-feedback so that it becomes personalised to their own learning**

Self-efficacy is one of the strongest contributors towards effective student learning (Hattie, 2015). An important component of self-efficacy is for the student to learn how to use the feedback provided through assessments for learning (Hattie & Timperley, 2007). Students who gain confidence and competency in accepting and providing feedback, also build belief in their own ability to learn (self-efficacy). This skill set is one of the most important, given the need going into the near future, for all workers to continue onwards as lifelong learners.

## Evaluation

### **Re-evaluate holistically**

Given the pedagogical and philosophical approaches underpinning the development and implementation of the sub-projects, from which these guidelines have been derived, it is important to ensure the instruments used to evaluate e-assessments are also valid, reliable and authentic. Of importance is to ensure the three guidelines – Selection, Deployment and Implementation – are accounted for. The evaluative tool needs to be well matched to the type of objective being measured. For example, in the Selection section, the key evaluation question will be to find out if the e-assessment approach actually enhances the learning outcome to be achieved. In the Development section, there may be exploration of the effectiveness of assisting teachers and students to become digitally fluent. The Implementation section may consist of a ‘stocktake’ of the effectiveness of the e-assessment approach, with data being collected from teachers, learners and learning analytics. These data may then inform the next iteration or development of e-assessments.

## **Keep up with the play**

The introduction of digital technologies to support learning and teaching means there is the need to constantly keep up with the rapid developments afforded by these technologies to support teaching and learning. For example, annual 'EDUCAUSE Horizon reports' (see Alexander et al., 2019 for the latest iteration) provide direction on some of the future trends for the introduction and utilisation of digital technologies in the higher education sector. These trends require careful consideration. Although many of the trends are attractive and relevant, the approach requires matching them to the learning outcomes to be achieved. Additionally, as many of the trends require extensive resourcing to develop: realistic objectives and scaffolded approaches to allow for digital literacy capability development are suggested. A cautionary note is also required due to the specialist nature of many vocational education programmes. This means that some specialised digital tools will be difficult and costly to adapt for wider learner audiences.

## Next Steps

### Meeting the objectives of the project

Table 2 summarises the connections between the project’s findings and guidelines, and the project objectives.

Objective	Evidence from project
<ol style="list-style-type: none"> <li>1. Align assessment to graduate profile outcomes.</li> <li>2. Assist learners to attain important multiliteracies (including academic, digital, cultural literacies and self-management and problem-solving traits) to meet graduate profile outcomes and as preparation for future lifelong learning.</li> <li>3. Provide e-assessment activities to support and enhance learning for disengaged learners.</li> <li>4. Acknowledge the worldview of learners’ different cultures and honour these in the design and implementation of curriculum and e-assessment practice.</li> <li>5. Extend the capabilities and potentialities of e-assessment beyond text-based paradigms.</li> </ol>	<ol style="list-style-type: none"> <li>1. Sub-projects focused on holistic outcomes. For example, to improve sensory evaluation, problem-solving, attitudinal approaches to safety, etc.</li> <li>2. As above, with emphasis on improvement of the multimodals and multiliteracies, which characterise vocational education.</li> <li>3. Sub-projects matched learning activities to learner profiles and needs, ensuring engagement by learners. Learner feedback collated by the sub-projects support this outcome.</li> <li>4. Encouraged learner co-creation of evidence of learning.</li> <li>5. Innovative use of technology supporting a range of multimodal learning activities e.g. using apps, OneNote, VR.</li> </ol>
<ol style="list-style-type: none"> <li>1. Transition from narrow task-based to authentic/holistic teaching, learning and assessment practices.</li> <li>2. Test the multiliteracies-based learning approaches’ alignment to graduate profile outcomes.</li> <li>3. Contextualise e-assessments for compatibility with vocational learning.</li> <li>4. Apply sound pedagogy to and evaluate innovative, leading edge e-assessment approaches, exemplified by e-Portfolios, role-play and simulation in virtual environments and VR platforms.</li> <li>5. Disseminate the guidelines through methods which will reach vocational</li> </ol>	<ol style="list-style-type: none"> <li>1. Holistic assessment for learning approaches were deployed.</li> <li>2. There was a good match between multiliteracies-based learning approaches and graduate profile outcomes.</li> <li>3. The e-assessments developed connected well with the precepts of vocational learning.</li> <li>4. Sound pedagogy ensured the learner and learning are at the centre of designing and implementing e-assessments for learning.</li> <li>5. A dissemination plan will be drawn up post-project.</li> </ol>

educator and workplace training audiences.	
<ol style="list-style-type: none"> <li>1. Increase expertise in e-assessment to achieve better outcomes for students, e.g. through real time tracking of student progress.</li> <li>2. Diversify delivery methods to meet the needs of a wider range of learners.</li> <li>3. Improve deployment of e-assessments across multiple campuses.</li> <li>4. Build capability for reflective practice, including through PAR, across Institutes of Technology and Polytechnics (ITPs) and other organisations.</li> <li>5. Identify synergies across sub-projects and organisations to ensure cross-pollination of good e-assessment for learning is implemented.</li> </ol>	<ol style="list-style-type: none"> <li>1. All the sub-project tutor/teacher participants, reported an increase in expertise.</li> <li>2. All the sub-projects included non-text-based evidence and feedback processes.</li> <li>3. Digital tools allowed for easier sharing of data across the sub-projects.</li> <li>4. There was engagement across the sub-projects and several still continue their PAR beyond the formal project completion.</li> <li>5. Workshop, at the beginning of the project, assisted in building relationships across sub-projects.</li> </ol>

*Table 2: Connecting project objectives to actual outputs*

## Conclusion

This report presents the learnings synthesised from the deployment of seven sub-projects on developing and utilising e-assessments for learning. Through a study of how these sub-projects were designed, developed and implemented, e-assessments for learning guidelines are proposed, rationalised and discussed. These guidelines provide a process for the selection and development, implementation and evaluation of assessments for learning, which support students to work towards the attainment of graduate profile outcomes-based qualifications.

Additionally, as prefaced in the section above on 'next steps', the project contributes a better understanding of the potentialities of e-assessments for learning for learners, tutors/teachers and organisations.



## References

- Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., McCormack, M., Pomerantz, J., Seilhamer, R., & Weber, N. (2019). *EDUCAUSE Horizon Report: 2019 Higher Education Edition*. Louisville, CO: EDUCAUSE, 2019. Retrieved May 2019 from <https://library.educause.edu/-/media/files/library/2019/4/2019horizonreport.pdf?la=en&hash=C8E8D444AF372E705FA1BF9D4FF0DD4CC6F0FDD1>
- Alterio, M., & Woodhouse, A. (2011). *Creating digital stories to enhance vocational learning*. <https://ako.ac.nz/knowledge-centre/creating-digital-stories-to-enhance-vocational-learning/creating-digital-stories-to-enhance-vocational-learning/>
- Apanui, N., & Kirikiri, T. (2015). *Hei Toko i Te Tukunga: Enabling Māori Learner Success*. Ako Aotearoa, New Zealand. [https://ako.ac.nz/knowledge-centre/hei-toko-i-te-tukunga-enabling-maori-learner-success/](https://ako.ac.nz/knowledge-centre/hei-toko-i-te-tukunga-enabling-maori-learner-success/hei-toko-i-te-tukunga-enabling-maori-learner-success/)
- Assessment Reform Group (ARG). (2002). *Assessment for learning: 10 principles*. [http://www.hkeaa.edu.hk/DocLibrary/SBA/HKDSE/Eng\\_DVD/doc/Afl\\_principles.pdf](http://www.hkeaa.edu.hk/DocLibrary/SBA/HKDSE/Eng_DVD/doc/Afl_principles.pdf)
- Barsalou, L.W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617-645.
- Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy and Practice*, 18(1), 5-25.
- Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, 32(3), 347-364.
- Billett, S. (2014). Mimesis: learning through everyday activities and interactions at work. *Human Resources Development Review*, 13(4), 462-482.
- Billett, S., & Choy, S. (2013). Learning through work: emerging perspectives and new challenges. *Journal of Workplace Learning*, 25(4), 264-276.
- Black, J. B. (2010). An embodied/grounded cognition perspective on educational technology. In M. S. Khine & I. M. Saleh (Eds.). *New Science of Learning: Cognition, Computers and Collaboration in Education*. New York, NY: Springer.
- Broadfoot, P., Oldfield, A., Sutherland, R., & Timmis, S. (2016). Seeds of change: The potential of the digital revolution to promote enabling assessment. In C. Wyatt-Smith, V. Klenowski, & P. Colbert (Eds.). *Designing assessment for quality learning* (p. 373-386). Heidelberg: Springer.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18 (1), 32-42.
- Campbell, J. P., DeBlois, P. B., & Oblinger, D. G. (2007). Academic Analytics: A New Tool for a New Era. *EDUCAUSE Review*, 42(4), 40-57.
- Chan, S. (2011). Becoming a baker: Using mobile phones to compile ePortfolios. In N. Pachler, C. Pimmer & J. Seipold (Eds.) *Work-based mobile learning: concepts and cases* (pp. 91-116). Oxford, UK; Bern, Switzerland: Peter Lang.
- Chan, S. (2013). *Learning a trade: Becoming a trades person through apprenticeship*. Ako Aotearoa Southern Hub. <https://ako.ac.nz/assets/Knowledge-centre/RHPF->

[s1301-Learning-a-trade/e9f27e46b3/RESEARCH-REPORT-Learning-a-Trade-Becoming-a-Trades-Person-through-Apprenticeship.pdf](https://www.ako.ac.nz/knowledge-centre/e9f27e46b3/RESEARCH-REPORT-Learning-a-Trade-Becoming-a-Trades-Person-through-Apprenticeship.pdf)

- Chan, S. (2015). Apprentices' learning of occupationally informed practical judgment. *Vocations and Learning: Studies in vocational and professional education*, 8(3), 335-351. <http://link.springer.com/article/10.1007/s12186-015-9134-3>
- Chan, S. (2016). New Zealand's move to graduate-profile framed qualifications: implications, challenges and the occupational identity solution. *International Journal of Training Research*, 14(1), 5-18. <http://www.tandfonline.com/doi/full/10.1080/14480220.2016.1156315#.VyEW8XF96VM>
- Chan, S. Fisher, K., & Sauer, P. (2014) Student Development of E-Workbooks: A Case for Situated-Technology Enhanced Learning (STEL) Using Net Tablets. In McConatha, D., Penny, C., Schugar, J. & Bolton, D. (Eds.) *Mobile Pedagogy: Perspectives on Teaching and Learning* (pp. 20 – 40). Hershey, PA: IGA Global.
- Chan, S., & Leijten, F. (2012). Using feedback strategies to improve peer-learning in welding. *International Journal of Training Research*, 10 (1), 23-29. <http://www.tandfonline.com/doi/abs/10.5172/ijtr.2012.10.1.23#.VaQ6sKON3Gg>
- Chan, S., Taylor, D., Cowan, L., & Davies, N. (2014, November). *Deploying student / peer feed-back to improve the learning of skills and dispositions with video*. In J. Clayton (Ed.). Sino / NZ VET Educational Research Forum, 2014 Conference Proceedings.
- Charteris, J., Quinn, F., Parkes, M., Fletcher, P., & Reyes, V. (2016). E-Assessment for learning and performativity in higher education: A case for existential learning. *Australian Journal of Educational Technology*, 32(3), 112-122.
- Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, 94(5), 1103-1127. DOI: [10.1037/a0016172](https://doi.org/10.1037/a0016172)
- Cochrane, T. D. (2010). Exploring mobile learning success factors. *Research in Learning Technology*, 18(2), 133-148. doi: [10.1080/09687769.2010.494718](https://doi.org/10.1080/09687769.2010.494718)
- Crisp, G. T. (2012). Integrative assessment: Reframing assessment practice for current and future learning. *Assessment and Evaluation in Higher Education*, 37(1), 33-43.
- Curtis, D.D. (2010). *Teaching, learning and assessment in TVET: The case for an ecology of assessment*. Australia: NCVET.
- Da Dalto, L., Balet, O., & Benus, F. (2010). *The use and benefits of Virtual Reality tools for welding training*. Paper presented at the 63rd Annual Assembly and International Conference of the International Institute of Welding, Istanbul, Turkey.
- Daly, C., Pachler, N., Mor, Y., & Mellar, H. (2010). Exploring formative e-assessments: Using case stories and design patterns. *Assessment and Evaluation in Higher Education*, 35(5), 619-636.
- Dann, R. (2014). Assessment as learning: blurring the boundaries of assessment and learning for theory, policy and practice. *Assessment in Education: Principles, Policy & Practice*, 21(2), 149-166. [http://discovery.ucl.ac.uk/1524755/1/Dann\\_assessment\\_as\\_learning\\_blurring\\_the\\_boundaries.pdf](http://discovery.ucl.ac.uk/1524755/1/Dann_assessment_as_learning_blurring_the_boundaries.pdf)

- Dawson, S., & Siemens, G. (2014). Analytics to literacies: The development of a learning analytics framework for multiliteracies assessment. *The International Review of Research in Open and Distance Learning*, 15(4), 284-305. <http://www.irrodl.org/index.php/irrodl/article/view/1878/3006>
- De Freitas, S., & Neumann, T. (2009). The use of 'exploratory learning' for supporting immersive learning in virtual environments. *Computers & Education*, 52(2), 343-352. <https://doi.org/10.1016/j.compedu.2008.09.010>
- Denton, D. W. (2012). Enhancing Instruction through Constructivism, Cooperative Learning, and Cloud Computing. *TechTrends*, 56(4), 34-41. Doi: [10.1007/s11528-012-0585-1](https://doi.org/10.1007/s11528-012-0585-1)
- Dimond, R., Bullock, A., Lovatt, J., & Stacey, M. (2016). Mobile learning devices in the workplace: 'As much a part of the junior doctors' kit as a stethoscope'? *BMC Medical Education*, 16(1), 207. <https://link.springer.com/article/10.1186/s12909-016-0732-z>
- Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learning and Instruction*, 13(5), 533-568. doi: [10.1013/S0959-4752\(02\)00025-7](https://doi.org/10.1013/S0959-4752(02)00025-7)
- Eisenhardt, K.M. (2002). Building theories from case study research. In A.M. Huberman & M.B. Miles (Eds.), *The qualitative researcher's companion* (pp. 5-35). Thousand Oaks, CA: Sage Publications.
- Ericsson, K. A. (2006). The Influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, P. J. Feltovich & R. R. Hoffman (Eds.), *The Cambridge Handbook of Expertise and Expert Performance*, (pp. 685-705). Cambridge, United Kingdom: Cambridge University Press.
- Fenwick, T., Edwards, R., & Sawchuk, P. (2011). *Emerging Approaches to Educational Research: Tracing the sociomaterial*. London, UK; New York, NY: Routledge.
- Fowler, C. (2015). Virtual reality and learning: Where is the pedagogy? *British Journal of Educational Technology*, 46(2), 412-422.
- Frielick, S., & Sciascia, D. (2016). *Learners and mobile devices: A framework for enhanced learning and institutional change*. <https://ako.ac.nz/knowledge-centre/learners-and-mobile-devices/learners-and-mobile-devices-a-framework-for-enhanced-learning-and-institutional-change/>
- Galarneau, L. L. (2005). *Authentic learning experiences through play: Games, simulations and the construction of knowledge*. Digital Games Research Conference 2005, Changing Views: Worlds in Play, June 16-20, 2005, Vancouver, British Columbia, Canada.
- Gamble, J. (2001). Modelling the invisible: The pedagogy of craft apprenticeship. *Studies in Continuing Education*, 23(2), 185-200. <https://doi.org/10.1080/01580370120101957>
- Gikandi, J.W., Morrow, D., & Davis, N.E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education*, 57(4), 2333-2351.
- Gros, B. (2016). The dialogue between emerging pedagogies and emerging technologies. In B. Gros, Kinshuk, M. Maina (Eds.), *The future of ubiquitous learning: Learning designs for emerging pedagogies* (pp. 3-23). Dordrecht: Springer.

- Goodyear, P. (2005). Educational design and networked learning: Patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, 21(1), 82–101. DOI: <https://doi.org/10.14742/ajet.1344>
- Gulikers, J. T. M., Bastiaens, T.J., Kirschner, P.A., & Kester, L. (2008). Authenticity is in the eye of the beholder: Student and teacher perceptions of assessment authenticity. *Journal of Vocational Education and Training*, 60(4), 401–412.
- Halpern, D. F. (1999). Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker. *New Directions for Teaching and Learning*, 80, 69–74.
- Hase, S., & Kenyon, C. (2013). *Self-determined learning: Heutagogy in action*. London, New York: Bloomsbury Academic.
- Hattie, J. (2015). The application of visible learning to higher education. *Scholarship of Teaching and Learning in Psychology*, 1(1), 79–91.
- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81–112.
- Heron, J., & Reason, P. (2001). The practice of co-operative inquiry: Research ‘with’ rather than ‘on’ people. In P. Reason & H. Bradbury (Eds.), *Handbook of action research: Participative inquiry and practice* (pp. 420–432). London, UK; Thousand Oaks, CA: New Delhi, India: SAGE publications.
- Herrington, J., Oliver, R., & Herrington, A. (2007). *Authentic learning on the web: Guidelines for course design*. Hershey, PA: Information Science Publishing.
- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235–266.
- Hodkinson, P., Biesta, G., & James, D. (2008). Understanding learning culturally: Overcoming the dualism between social and individual views of learning. *Vocations and Learning*, 1(1), 27–47.
- Jacobs, G. E. (2013). Designing assessments: A Multiliteracies approach. *Journal of Adolescent & Adult Literacy*, 56(8), 623–626. DOI: [10.1002/JAAL.189](https://doi.org/10.1002/JAAL.189)
- Jenkins, H. (2006). *Confronting the challenges of participatory culture: Media education for the 21st century*. Chicago, IL: MacArthur Foundation. DOI: [10.7551/mitpress/8435.001.0001](https://doi.org/10.7551/mitpress/8435.001.0001)
- Johansson, M. W., Wärvik, G-B., & Choy, S. (2018). Vocationalising Specialized Concepts: Appropriating Meanings Through Feedback. *Vocations and Learning*, pp 1–19. <https://doi.org/10.1007/s12186-018-9204-4>
- Kalantzis, M., Cope, W., & Harvey, A. (2003). Assessing multiliteracies and the new basics. *Assessment in Education: Principles, Policy and Practice* 10(1), 15–26.
- Kimber, K., & Wyatt-Smith, C. M. (2016). Designing next-generation assessment. In C. Wyatt-Smith, V. Klenowski, & P. Colbert (Eds.), *Designing assessment for quality learning* (p. 357–372). Heidelberg: Springer.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK; New York, NY: Cambridge University Press.
- Leser, R., Baca, A., & Uhlig, J. (2011). Effectiveness of multimedia-supported education in practical sports courses. *Journal of Sports Science and Medicine*, 10(1), 184–192.

- Loke, S-K. (2014). How do virtual world experiences bring about learning? A critical review of theories. In B. Hegarty, J. McDonald, & S-K. Loke (Eds.), *Rhetoric and reality: Critical perspectives on educational technology*. Proceedings Ascilite Dunedin 2014 (pp. 129-139).
- Marchand, T. H. J. (2007). Crafting knowledge: The role of 'parsing and production' in the communication of skill-based knowledge among masons. In M. Harris (Ed.), *Ways of Knowing: New Approaches in the Anthropology of Knowledge and Learning* (pp. 181-202). New York, NY: Berghahn Books.
- Mason, A., Yerushalmi, E., Cohen, E., & Singh, C. (2016). Learning from mistakes: The effect of students' written self-diagnoses on subsequent problem solving. *The Physics Teacher*, 54(2), 87-90. DOI: [10.1119/1.4940171](https://doi.org/10.1119/1.4940171)
- McLaughlin, E. (2017). *Exploring the language and literacies of the trades: learning through practice*. Poster presentation at the 26th National Vocational Education and Training Research Conference, 5-7 July 2017, Hobart, Tasmania.
- Miller, C., & Bartlett, J. (2012). Digital fluency: towards young people's critical use of the internet. *Journal of Information Literacy*, 6(2), pp.35-55. <http://ojs.lboro.ac.uk/ojs/index.php/JIL/article/view/PRA-V6-I2-2012-3>
- Moran, A., Campbell, M., Holmes, P., & MacIntyre, T. (2012). Observation, learning and skill acquisition in sport. In A. M. Williams & N. J. Hodges, (Eds.), *Skill Acquisition in Sport: Research, Theory and Practice*, 2nd ed. London: Routledge.
- Moscrop, C., & Beaumont, C. (2016). Technology-enhanced assessment feedback. In D. Carless, S. M. Bridges, C. K. Y. Chan, & R. Glofcheski (Eds.), *Scaling up assessment for learning in higher education* (pp.193-207). Singapore: Springer.
- NZQA. (2018). *Guidelines for applying for approval of programmes leading to New Zealand qualifications at Levels 1-6 on the NZQF and the accreditation of organisations to provide approved programmes*. Wellington, New Zealand: NZQA. <https://www.nzqa.govt.nz/assets/Providers-and-partners/Registration-and-accreditation/Programme-approval-and-provider-accreditation/guidelines-programme-approval-accreditation-level1-6.pdf>
- Parkinson, J., Coxhead, A., Demecheleer, M., Mackay, J., Matautia, L., McLaughlin, E., & Tu'amoheloa, F. (2017). *The Language in the Trades*. <https://ako.ac.nz/knowledge-centre/the-language-in-the-trades/the-language-in-the-trades-education-2017/>
- Poushter, J. (2016). *Smartphone ownership and internet usage continues to climb in emerging economies*. Pew Research Center, Washington, DC, USA. <http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/>
- Productivity Commission. (2015). *New models of tertiary education: Issues paper*. <http://www.productivity.govt.nz/sites/default/files/tertiary-education-issues-paper.pdf>.
- Pryor, J., & Crossouard, B. (2010). Challenging formative assessment: Disciplinary spaces and identities. *Assessment & Evaluation in Higher Education*, 35(3), 265-276.
- Sadik, A. (2008). Digital storytelling: a meaningful technology-integrated approach for engaged student learning. *Educational Technology Research and Development*, 56(4), 487-506. DOI: 10.1007/s11423-008-9091-8

- Sadler, R. (2009). Transforming holistic assessment and grading into a vehicle for complex learning. In G. Joughin (Ed.), *Assessment, Learning and Judgement in Higher Education* (pp. 45-64). Netherlands: Springer.
- Sadler, R. (2010). Beyond feedback: Developing student capability in complex appraisal. *Assessment and Evaluation in Higher Education*, 35(5), 535-550.
- Schön, D. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Selander, N. S. (2016). Conceptualisation of multimodal and distributed designs of learning. In B. Gros, Kinshuk, M. Maina (Eds.), *The future of ubiquitous learning: Learning designs for emerging pedagogies* (pp. 97-113). Dordrecht: Springer.
- Sennett, R. (2008). *The Craftsman*. London: Allen Lane.
- Spence, C. (2017). *Gastrophysics: the new science of eating*. London: Viking.
- Stone, R. T., McLaurin, E., Zhong P., & Watts, K. P. (2013). Full Virtual Reality vs. Integrated Virtual Reality Training in Welding. *Industrial and Manufacturing Systems Engineering*, 92(6), pp167-174.  
[http://lib.dr.iastate.edu/imse\\_pubs/?utm\\_source=lib.dr.iastate.edu%2Fimse\\_pubs%2F43&utm\\_medium=PDF&utm\\_campaign=PDFCoverPages](http://lib.dr.iastate.edu/imse_pubs/?utm_source=lib.dr.iastate.edu%2Fimse_pubs%2F43&utm_medium=PDF&utm_campaign=PDFCoverPages).
- Stowell, R., & Lamshed, R. (2011). *E-assessment guidelines and case studies*. Australian Flexible Learning Network. Canberra, ACT: Department of Education, Employment and Workplace Relations, Australian Government.  
<https://www.voced.edu.au/content/ngv%3A46939>
- Syed, A. M. (2016). Framework to develop a learning analytics system for smartphone blended learning environment. In L, Briz-Ponce, J. A. Juanes-Méndez and F. J. García-Peñalvo (Eds.). *Handbook of Research on Mobile Devices and Applications in Higher Education Settings*. Hershey, PA: IGI Global.
- Tertiary Education Commission (TEC). (2015). *Tertiary Education Strategy 2014-2019*.  
<http://www.education.govt.nz/further-education/policies-and-strategies/tertiary-education-strategy/>
- Teaching and Learning Research Initiative. (2008). *Research priorities in the tertiary sector: excerpts from an interview with Dr Peter Coolbear*.
- Terrell, J., Hay, D., Haines, K., Schwenger, B., Smith, M., & Snell, D. (2016). *Getting it right: Guidelines for Online Assessment in New Zealand Tertiary Contexts*. Wellington, New Zealand: Ako Aotearoa.  
<https://ako.ac.nz/assets/Knowledge-centre/RHPF-N65-Getting-it-right-Guidelines-for-online-assessment/34a68c566b/GUIDELINES-Getting-it-Right-Guidelines-for-Online-Assessment-in-New-Zealand-Tertiary-Contexts.pdf>
- The New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60-93.
- Tiruneh, D., Cock, M., & Elen, J. (2017). Designing learning environments for critical thinking: Examining effective instructional approaches. *International Journal of Science and Mathematics Education*, 16(6), 1065-1089. DOI: [10.1007/s10763-017-9829-z](https://doi.org/10.1007/s10763-017-9829-z)
- Vaughan, K. (2008). *Workplace learning: A literature review*. Auckland, New Zealand: Competenz.  
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.583.3485&rep=rep1&type=pdf>

Wadsworth, Y. (2001). The mirror, the magnifying glass, the compass and the map: Facilitating participatory action research. In P. Reason & H. Bradbury (Eds.), *Handbook of action research: Participative inquiry and practice* (pp. 420-432). London, UK; Thousand Oaks, CA; New Delhi, India: SAGE publications.

We are Social. (2017). *Digital in 2017: Global Overview*.  
<https://wearesocial.com/special-reports/digital-in-2017-global-overview>

Wikipedia. (2017). *List of countries by number of mobile phones in use*.  
[https://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_number\\_of\\_mobile\\_phones\\_in\\_use](https://en.wikipedia.org/wiki/List_of_countries_by_number_of_mobile_phones_in_use)

Williams, B.T. (2008). "Tomorrow will not be like today": Literacy and identity in a world of multiliteracies. *Journal of Adolescent and Adult Literacy*, 51(8), 682-686.

# Appendices

## Multimedia use in learning to kayak



### Steve Chapman

The use of various multimedia components in the teaching and learning of sport have become standard forms in education (Leser, Baca & Uhlig, 2011). It has been used for teaching students motor skills in various sports. The main aim of the sub-project study reported here, was to better understand what effect multimedia could have in assisting Outdoor Education students learning to whitewater kayak.

### Rationale

For over half a century, video has been used to provide feedback on performance and to promote self-reflection, self-assessment, and self-confrontation (Fuller & Manning, 1973). Technology has developed at such a fast rate that it is now normal to have learning environments full of technology. Technologies such as smartphones and tablets in combination with social media have contributed to increasing social interaction and made it easier to integrate video applications into education.

Several studies show multimedia being used in the teaching of motor skills for sport activities, such as swimming, boxing, table tennis, handball, fencing, basketball, and soccer (Selim & Mohamed, 2010; Vernadakis, Zetou, Giannousi & Kioumourtzoglou, 2006). However, there was no study to be found on research into the effect of multimedia on learning to whitewater kayak. Learning to whitewater kayak is often referred to as a counterintuitive process (Dillon & Oyen, 2008; Jackson, 2016). An example of this is learning to 'roll' the kayak back upright from a capsized position. It makes sense to lift your head to lift your body out of the water, however what you have to do is rotate the kayak under you before lifting your head, when all you want to do is lift your head for a breath.

Students learning to whitewater kayak, also, often experience quite a 'difficult' period of learning as the sport of kayaking is more complex than expected and is often not understood by most students. Therefore, this sub-project was focused on gaining a better understanding of the effect that multimedia might have on assisting Outdoor Education students learning to whitewater kayak. Considered alongside this is the effect multimedia might have on the learning process, a process that can be quite frustrating for students who are learning a counterintuitive and, surprisingly, a complex sport.

### Introduction

Learning to whitewater kayak has many aspects (e.g. using technical motor skills, reading river hydrology, using rescue skills, trip planning, etc.). To manage the size of



the sub-project with the available time, I focused specifically on learning how to perform a 'kayak roll' (a roll is where a kayak is re-righted from a capsized position) and the learning process itself. Learning how to 'kayak' on one level is quite straightforward, however to be a competent kayaker takes considerable time and effort. The successful outcome of this learning is where students have developed a reliable 'kayak roll' which enables them to be self-sufficient on watercourses. This is just one of the numerous skills required to be able to work in outdoor education and adventure tourism and take responsibility to guide and instruct learners and tourists in risky and dynamic water environments. As already discussed above, students studying towards this level of competence often experience quite a 'difficult period' of learning, both in terms of the technical motor skills required and, also, managing the frustration that can be experienced through the counterintuitive nature of the sport.

The sub-project occurred during a practical skills development course(s), where students were either part of a diploma of outdoor leadership programme (a 1-year programme at level 5) or a degree in outdoor education programme (a 3-year programme at levels 5-7). Level 5 students complete a compulsory course called Practical Leadership – Water Journeys, where the aim is to identify, gain and enhance the skills necessary to be a competent role model for beginner groups in a range of water-based activities. The level 6 students chose an elective course called Advanced Practical Pursuit – Whitewater Kayak, where the aim is to gain and enhance the skills and knowledge necessary to be a competent role model for an intermediate client group, be able to provide leadership with intermediate groups in river environments, and be able to interpret the environment of inland waterways within Aotearoa NZ.

Students in the level 5 course received 10 full days and 2 half days of tuition about kayaking; they received at least 7 tuition sessions in heated swimming pools, freshwater lakes and on the river. There were two occurrences of this course, and a total of 34 students were involved. Level 6 students received 4 two-hour sessions and 8 full days of tuition where rolling the kayak was taught through at least 7 sessions in heated swimming pools, freshwater lakes and on the river. There was one group of 9 students involved. These lessons occurred from early February to early April 2017.

Assisting the tutors were L7 students (3<sup>rd</sup> year degree students), who were gaining practical experience in the planning, delivery and assessment of outdoor education programmes.

## **Literature Review**

There seems to be a consensus in the research literature that video, when used effectively, can be an efficient educational tool (Zahn et al., 2012). In particular, interactive multimedia is one of the most important applications of technology. Interactive multimedia involves text, image, sound, graphics, etc., in a learning environment where the students can affect their own learning stages and determine those that fit their learning style (Dania et al., 2011).

A meta-study of video-supported feedback in education and training concludes that video feedback is “an effective method that contributes to a wide range of key professional skills” (Fukkink et al., 2011, p. 56). Learning can be significantly enhanced through video-supported feedback and is particularly useful in areas such as medicine and sport (Farquharson et al., 2013; O'Donoghue, 2006), where skills and capability are clearly observable through recorded footage of actions. However, while video and

multimedia footage with feedback can play an important role in student learning, not all uses of video and multimedia are equally beneficial. Any critique offered to the learners must be applicable and focused on key learning priorities to help development, otherwise learners will fail to recognise the most important and substantive aspects that they need to focus on. One of the key aspects making video feedback unique is that it allows course participants to look at themselves 'from a distance' and with space for reflection, thereby giving them a realistic picture of their own skills (Fuller & Manning 1973; Hargie et al., 1983). It shows how the students have performed, rather than how they think they have performed, and provides a more objective or realistic picture than is provided through recollection.

While video provides students with the opportunity to examine their own ability, tutors still remain central in shaping discussions and student perceptions. It is argued, for instance, that instructional questions can focus the attention of the participants while watching the footage, and enable them to stay 'on track' and address the intended issue during the discussion (Borko et al., 2011, p. 175). Zahn et al. (2012) suggests video is one of the most popular forms of educational media across the curriculum and plays an increasingly important role in classroom learning. Many studies have a focus on measured success or perceived effectiveness of video-based feedback, which provide evidence that video is a useful tool and demonstrates the importance of additional guidance. The video alone does not itself guarantee success. As Fukkink et al. (2011) have said, unguided viewing of video footage can lead to a focus on superficial impressions that would require tutor effort to redirect the students' attention to the important aspects. Without further guidance, students might find themselves at sea, in a stream of continuous detail they are unable to deconstruct and make sense of (Erickson, 2007). Other researchers, however, emphasise that video is "an inherently ambiguous and incomplete stimulus that invites reaction and speculation ranging far beyond the information that is potentially available in the video clip itself" (Erickson 2007, p. 152). Yet, in contrast, multimedia offers opportunities for personalised instruction, cooperation, communication and feedback (Leijen et al., 2008).

In summary, video provides a resource for observing one's own actions from a third-person perspective. Video is used to objectify what truly happened; but, in addition, the third-person perspective of the video is used to reconceptualise how the students' performances are to be seen and assessed. The video recordings become a central resource in guiding students' focus, and the distinction between actuality and perceived reality is made relevant in terms of good practice. Researchers suggest teachers take a more 'holistic approach' when teaching motor skills, one where many teaching methodologies are used and include teaching across a range of learning domains, e.g. motor and cognitive (Dania, et al., 2011). The use of technology in education should not be encountered as an end in itself, it is a useful pedagogical tool.

## **Method**

The main objective of this sub-project was to better understand what effect multimedia could have in assisting Outdoor Education students learning to whitewater kayak. Data collection for the sub-project was carried out through practical class lessons, a postal survey and by questioning students in the learning environment. The responses were analysed to identify key ideas, which were then clustered together to produce themes.

A case study research approach was taken because the study focused on a particular situation. It is a method used to narrow down a very broad field of research into one easily researchable topic. Whilst it will not answer a question completely, it will give some indications and allow further elaboration on a subject. An advantage of the case study approach was the ability to hone in on specific aspects, where the focus is deliberately trying to isolate a particular problem(s) (Shuttleworth, 2008). Case studies do have certain disadvantages that may include a lack of rigor, challenges associated with data analysis and very little basis for generalisations of findings and conclusions; therefore this study was recreated during the 2018 kayak courses to check the validity of the findings.

### **Ethical Considerations**

Research will always have ethical dilemmas, and this study was no different. Firstly, a proposal documenting the intended research purpose, rationale, and significance was completed. This included details about how the research would be carried out, who the participants would be, and a discussion around identified ethical issues. The main issues identified were:

- the need to minimise the risk of harm to participants;
- the need for informed and voluntary consent;
- the need to be respectful of privacy and confidentiality;
- the need to avoid any deception;
- the avoidance of conflict of interest.

The documentation was submitted to the Ara Research Ethics Committee for approval. The research was approved as low risk.

### ***How things developed***

Prior to the start of practical classes, students attended a meeting where the sub-project was introduced to them, and their voluntary participation sought. At the same time, students received information about pre-learning aspects of their course; for example, students were encouraged to preview several whitewater kayak rolling videos before the practical teaching session(s) began. Students were sent email links to YouTube videos and library DVDs through the Moodle student learning platform and a closed group Facebook page, as well as receiving a handout on the topic at the introductory meeting. The idea was to expose students to several aspects that may assist their learning, including:

1. gaining an overall picture of the kayak roll in controlled environments
2. understanding some of the language and terminology used in describing the kayak 'roll'
3. making students aware of the kind of physical motor skill progressions that they might experience
4. watching multimedia footage of the kayak 'roll' being applied in the intended environments.

At the start of the practical learning session, after an initial introduction to gear, equipment and clothing options, students were asked about what multimedia they had reviewed and their understanding of it; notes were then made to capture this information. Students were then guided through several practical lessons where they were exposed to some straightforward exercises (although these can prove quite challenging for some, especially if they have a fear of water or of being upside down in a kayak) designed to help build trust between the tutor and the student, as well as helping the student gain confidence being upside down in a kayak. This involved activities like the student capsizing the kayak and being re-righted by the tutor to avoid exiting the kayak and the student capsizing and counting to 10 while upside down. These exercises ensure students can safely exit the kayak or self-rescue if they need to. Given the student(s) were about to spend a considerable amount of time upside down, it was important to ensure this first stage provided students with high levels of underwater confidence and trust. Failure to achieve this might hinder student progress and the roll progression may become a struggle for everyone. Two other key factors can limit success with the rolling progression; getting cold and getting water up their nose. To assist students with these two factors, they were initially taught in a heated swimming pool and, secondly, were advised to wear either a nose clip or dive mask to prevent water entering their nose when capsized.

A rolling progression was then implemented with each student. While there are many ways to teach kayak rolling the typical approach involves one-to-one instruction. This is predominately because it involves students connecting a number of motor skills, physical movements that are connected but independent of each other and therefore complex to do together, for example, lifting a knee in the kayak while upside down and at the same time also moving their arm in order to move the paddle, among a number of other related movements. In order for these individual physical movements to be linked together, each student needs to be physically held by a tutor who is standing in the pool. This approach allows the student to remain in their kayak and to be pulled up when they get out of breath instead of exiting the kayak, which saves time and allows for a high number of supervised repetitions. This approach also allows the tutor to isolate each individual motor skill while providing immediate feedback about what has just occurred, or asking the student for their feedback on what just happened. However, this creates a bottleneck where students are reliant on tutor contact time to progress, hence the use of multimedia to assist their learning. When they are not in the pool, students are either resting, observing others learning, practising a particular skill on the side of the pool (although this practice can lead to students practising motor skills incorrectly, which then may require unlearning) or filming others, thereby learning basic technology skills. During this first phase, students are repeatedly asked questions about the kayak roll progressions to check they understand what they are meant to be doing with various parts of their body, e.g. what their knee should be doing inside the kayak. This feedback is not always well understood, or it is confusing for the students, because rolling is a disorientating process and it's difficult to visualise correctly because students are upside down.

At this point, students were filmed on video cameras, tablets and smartphones. The purpose of this was for the student to be able to self-review the camera footage immediately to help them identify issues and strengths in their practice. The details were provided as a continuous stream of footage, which was then broken down into

frame by frame sequences. This supported the oral feedback given by the tutor and offered another format to assist the student to learn. The tutor and the student work together to identify the issues and look for understanding and solutions. Further demonstrations and the use of multimedia are used to help students see a positive image and to create a step by step approach to their development.

## **Findings**

### **Pre-learning**

Many students were positive about viewing the suggested YouTube video clips and the DVDs prior to the practical lessons. Comments such as the ones below were common:

1. It gave me a head start.
2. I was able to understand how to roll and rescue without having done it.
3. It gave me a good basic introduction.

### **Immediate feedback**

Most students gave favourable responses to the instant feedback that the multimedia footage provided. Comments such as the ones below were common:

1. I was able to see myself and actually know what they (tutor) were saying.
2. I could see my faults for myself and picture what I needed to change.
3. It helped me to understand the oral feedback that was being provided.

### **Ongoing demonstrations and multimedia viewing**

Tutors and L7 students (3<sup>rd</sup> years) offered positive demonstrations for the students, so they were able to visualise how it should be done. They also had the opportunity of viewing multimedia footage when they were resting between the practical sessions. Most students commented positively about the ongoing opportunities to learn the kayak roll through multiple approaches and mediums.

### **Survey responses from previewing the YouTube videos and the DVDs**

The survey responses presented a number of mixed themes and comments:

1. Some students commented that some of the videos on YouTube or in the DVD library were somewhat dated and therefore uninteresting to watch or learn from.
2. Some students found the videos too long winded.
3. Some students suggested that without direct practise, they found it difficult to remember the steps suggested in the videos.
4. Students also suggested that continuing to add shorter videos in between sessions could help.
5. Students wanted to access the videos from one source, and be able to watch them at home when they wanted to study. This would make it easier for them, rather than having to be in the library.

## Survey responses to the practical filming

1. There is a need to ensure all students get a quality video of themselves. It was noted that some students appeared to have missed out on being videoed.
2. All students suggested that there should be more of it, as it was super helpful having the video footage, plus the teachers' comments and feedback, immediately after the event.

## Discussion

Given that the process of learning to 'roll' is counterintuitive and takes time to learn, and tutor contact hours with students are extremely limited, tutors have been developing strategies around the use of multimedia and other digital technologies to aid and support learners.

The opportunity for students to view, review and receive detailed feedback for each performance appears to have assisted in learning. The main improvements in learning are now detailed.

Student learning appears to have been accelerated; most students had some sort of roll after 3 or 4 lessons. The videoing of students' performances has to some degree decreased the required time to gain the rolling skill. It also seemed to reduce student frustration levels. With the use of multimedia, students were able to continue learning outside of direct tutor contact time. While tutors continued to provide feedback to individual students, groups of students were also able to provide feedback to each other by pausing or running the multimedia footage in slow motion. Students were then able to proceed with deliberate practice both during and outside timetabled class time.

Improved student self-awareness about what their bodies were doing during deliberate practice was key in this development. In the past, feedback from tutors had caused confusion and frustration for the learner, as verbal feedback is less clear than reviewing actual video footage of their performance. While the feedback confusion and frustration at the learning process might not be entirely removed, the use of multimedia has illustrated an improvement in the learning environment. The video evidence shows students what they are actually doing rather than what they think they were doing. In other words, the video doesn't lie, it provides a real time example of what the student is struggling with or doing well. While the video footage clearly provided formative feedback to students, the footage captured also offered opportunities to record progressive improvements in students' performance and could potentially be used as summative evidence for assessment purposes and for moderation purposes.

As discussed above, using deliberate practice to learn complex motor skills takes time, diligence and support. In this study, students were generally highly motivated, because being able to roll the kayak has a high status in their view.

Also, it is an assessment task that must be achieved. Observations from tutors indicated that most of the students had a strong willingness to work through the necessary skill acquisition progressions using repetitive practice. The immediacy of feedback provided by using tablets to record roll practice and the ease with which the recorded roll learning and practice could be shared with tutors, fellow students and sometimes with the whole class, was of real benefit. Students were asked if their videos could be shown to the whole class if the tutor thought there was value in doing so, with the aim of clarifying understanding and enhancing opportunities for learning. The use of viewing exemplars and learning from mistakes proved highly successful. Asking students' permission before their video footage was shown to the entire class or sub groups of the class provided a safe and supportive learning environment by which students could critique each other and learn from each other in a positive manner. There was also increased understanding of what constituted good form in practice. Students could build up a visual library with supporting theory to enable them to make a judgement on what good practice was.

The students talked about their performance, how they were doing some aspects of the roll and what was missing in their performance. Without the video, the students would not be able to talk about their performances through their learning process in this way; more specifically, they would not have the same access to a third-person perspective about their own development.

The digital tools of choice, small tablets or smartphones in waterproof cases, e.g. Ipad minis, are ideal as they are small enough to use in various outdoor environments, especially if supported with LifeProof cases. Apple and Samsung smartphones are even more compact than Ipads and, in some cases, are already waterproof. Removing the barrier of access to appropriate digital tools would likely increase students' learning opportunities.

## References

- Baptiste, I. A., & Brookfield, S. D. (1997). Your so-called democracy is hypocritical because you can always fail us: learning and living democratic contradictions in graduate adult education. In Armstrong, P. (Ed.), *Crossing Borders, Breaking Boundaries: Research in the Education of Adults*. London: Department of Adult Education, Birkbeck College, 1997.
- Borko, H., Koellner, K., Jacobs, J., & Seago, N. (2011). Using video representations of teaching in practice-based professional development programs. *ZDM Mathematics Education*, 43(1), 175–187.
- Brookfield, S. (2015). *The skillful teacher: On technique, trust, and responsiveness in the classroom*. Third edition. USA: John Wiley & Sons.
- Brookfield, S. (1996). Through the Lens of Learning: How Experiencing Difficult Learning Challenges and Changes Assumptions About Teaching. *To Improve the Academy*, 15(1), 3–15.
- Dania, A., Hatziharistos, D., Koutsouba, M., Tyrovola, V. (2011). The use of technology in movement and dance education: recent practices and future perspectives. *Procedia Social and Behavioral Sciences* 15, 3355–3361.

- Dillon, P. & Oyen, J. (Eds.). (2008). *Kayaking*. Outdoor Adventure Series. USA: Human Kinetics.
- Erickson, F. (2007). Ways of seeing video: Towards a phenomenology of viewing minimally edited footage. In R. Goldman, R. Pea, S. Barron, & S. J. Derry (Eds.), *Video Research in the Learning Sciences* (pp. 145-155). Mahwah: Lawrence Erlbaum Associate Publishers.
- Farquharson, A. L., Cresswell, A. C., Beard, J. D., & Chan, P. (2013). Randomized trial of the effect of video feedback on the acquisition of surgical skills. *British Journal of Surgery*, *100*(11), 1448-1453.
- Fukkink, R. G., Trienekens, N., & Kramer, L. J. C. (2011). Video feedback in education and training: Putting learning in the picture. *Educational Psychology Review*, *23*(1), 45-63.
- Fuller, F. F., & Manning, B. A. (1973). Self-confrontation reviewed: A conceptualization for video playback in teacher education. *Review of Educational Research*, *43*(4), 469-528.
- Hargie, O., Saunders, C., & Dickson, D. (1983). *Social skills in interpersonal communication*. Hoboken, NJ: Wiley.
- Jackson, E. (2016). *Kayaking with Eric Jackson: Rolling and bracing*. Mechanicsburg, PA, USA: Stackpole Books.
- Leser, R., Baca, A. & Uhlig, J. (2011). Effectiveness of multimedia-supported education in practical sports courses. *Journal of Sports Science and Medicine*, *10*(1), 184-192.
- O'Donoghue, P. (2006). The use of feedback videos in sport. *International Journal of Performance Analysis in Sport*, *6*(2), 1-14.
- Perna, L. W. (Ed.). (2010). *Understanding the working college student: new research and its implications for policy and practice*. Sterling, VA: Stylus Publishing.
- Selim, I. & Mohamed, H. (2010). Effectiveness of Using an Instructional Multimedia Program in Learning Some Basic Motor Skills for the Pre-School Children. *World Journal of Sport Sciences*, *3*(S), 247-251.
- Shuttleworth, M. (2008). *Case Study Research Design*. Retrieved from <https://explorable.com/case-study-research-design>
- Vernadakis, N. A., Avgerinos, A., Zetou, E., Giannousi, M. & Kioumourtzoglou, E. (2006). Comparison of Multimedia Computer Assisted Instruction, Traditional Instruction and Combined Instruction on Learning the Skills of Long Jump. *International Journal of Computer Science in Sport*, *5*(1), 17-32.
- Zahn, C., Krauskopf, K., Hesse, F. W., & Pea, R. (2012). How to improve collaborative learning with video tools in the classroom? Social vs. cognitive guidance for student teams. *International Journal of Computer-Supported Collaborative Learning*, *7*(2), 259-284.



## E- assessment of work integrated learning in quantity surveying



**Keith Power**

### **Background**

In February 2017 Ara commenced delivery of work integrated learning (WIL) within the New Zealand Diploma in Construction (Quantity Surveying). The diploma programme includes a total of 120 hours of WIL in year two. The structure and timing of these hours is incorporated across three courses: Measurement – Commercial, Measurement – Services and Civils, and Procurement. WIL was informed by the work on practice-based learning (Billett, 2015) which advocates preparation of learners before, during and after WIL.

### **Preparation**

This being the first time WIL had been organised, some preparatory work was required in securing work placements and appointing staff to coordinate placements. It was therefore not until July 2017 that the first group of students commenced their work integrated components. A part-time WIL coordinator was appointed to arrange placements, to meet with students and employers during the placement, and to provide day to day liaison. A total of 16 students were placed on WIL between July and December 2017. A second cohort of 15 students are currently on placement having commenced WIL in January 2018.

Some challenges were faced in meeting employer requirements, such as employers' requests to interview and/or select students prior to commencing WIL. Some employers had their own 'volunteer' contracts for the students sign. Others required students to undertake drug tests and, in one case, a medical examination prior to commencing the placement.

Before commencing their placements, students were introduced to OneNote Class Notebook and received instruction on their role and responsibilities, such as health and safety, confidentiality of commercially sensitive information, and what to do in the event of sickness and absence from work.

### **During**

Students were required to complete an e-portfolio using OneNote Class Notebook as well as assessment components for individual courses. They recorded a log of the tasks carried out on placement and the number of hours worked in OneNote Class Notebook. The WIL Coordinator kept in touch with students and arranged face to face meetings with students via OneNote.

Assessments for work integrated components within the individual courses were submitted separately and marked by relevant course tutors. Work integrated components generally required students to complete limited sections of their assignments to the requirements of their work experience employers. Any

differences in approach were highlighted, analysed and reported on within the assignment for the course, not on OneNote Class Notebook. Course assignments were submitted electronically and on paper to course tutors.

Feedback was sought from students individually, and a focus group discussion was held with a group of five students from the first cohort.

### **Feedback from students**

All students gave positive and appreciative feedback about their experiences on placement, e.g.: “The WIL at [name of WIL placement firm] certainly gave me something to talk about in my interview at [name of current employer], and T., the senior QS at [name of WIL placement firm] was one of my referees, so the WIL placement definitely paid off.”

Most found that the placement was well organised; the employers looked after them (e.g. took them out on site visits) and provided a variety of work and different types of projects to do.

When asked about their preparation and readiness for work placement, students thought they were well prepared for the following:

- Knowledge of building construction
- Measurement of quantities in accordance with the New Zealand Standard Method of Measurement
- Respecting confidentiality of commercially sensitive information
- Use of Excel spreadsheets.

Areas where they felt they lacked preparation for placement included:

- Dealing with large sets of documents including document management systems
- Reading complex drawings
- Coping with incomplete and poor documentation and project information
- Awareness of the various QS roles and employers.

The documentation (drawings and specifications) used in the first year of the course did not prepare students for work experience. All students at the focus group agreed that the standard of documentation in the real world was below that used at polytechnic, but was more complex and extensive. They would therefore like more use of large sets of documents and guidance on how to deal with incomplete documentation, including when it should be rejected.

Ara teaches the use of current quantity surveying (QS) specialised software (CostX), but this was not found at most placements. Students reported little need for more advanced spreadsheet skills such as macros and producing charts, but more coverage of sorting and processing of costing and estimating data was necessary.

Students commented on the variety of QS roles and cultures evident in various parts of the industry. They suggested more guidance on the differences in roles, e.g. when working in contractors’ and private QS offices, as well as with subcontractors and suppliers. Regarding an explanation of the differences between contractors and private firms one student said: “...maybe not in the first year but in the second year [differences in roles and culture] could be explained more... The lingo is different.

In a private firm it is more professional”. Similarly, QS roles with specialist subcontractors and suppliers were overlooked: “There are more subcontractors, more opportunities...”

OneNote Class Notebook held general course and assessment information, details of WIL arrangements and helpful tips and hints on employment.

Some students did not hold the Site Safe Passport, required for work on construction sites, prior to commencement of work placement, although this is arranged by the polytechnic for students in year one of the programme.

## **E-Literacies**

Students did not submit their assessments for the individual courses in OneNote Class Notebook and consequently recorded only their worked hours and tasks completed. They said they did not use it to collect information for assessment because it would not affect their marks and they wanted to get on with their work at the placement.

All students thought they already had sufficient literacy in email, CostX and Excel. One student was now working as a BIM (Building Information Management) coordinator and suggested that students should be able to highlight and annotate PDFs to facilitate communication of information about discrepancies to designers. This would extend to annotation of BIM models using BIM software such as NavisWorks. Similarly, one student suggested that there should be familiarisation with the use of Aconex cloud-based construction management software, which is widely used in industry to manage documentation, and BIM models.

## **Conclusions**

The following recommendations were identified through analysis of student feedback and researcher reflection:

- Effective coordination of work placement requires sufficient lead time and adequate staffing resources, largely due to the logistics of coordinating placements and managing employer expectations.
- Consider configuring WIL components into just one full year course rather than across several single semester courses.
- Students submitting work for assessment using OneNote Class Notebook must be a requirement of the course, rather than optional. Students are unlikely to use e-assessment by free choice.
- Familiarity with Aconex cloud-based construction management software and annotation of PDF's should be included prior to commencement of work placements.
- Need to ensure that full-time students have completed a Site Safe Passport prior to commencing work integrated learning.
- Students confirmed the value of this work experience.

## **References**

Billett, S. (2015). *Integrating practice-based experiences into higher education*. Dordrecht, Netherlands: Springer.

## Developing reflective practice of level 4 cookery students through sensory analysis of food



**Cheryl Stokes**

### Introduction

#### Background information

The Cookery section of the Department of Hospitality and Service Industries (HSI), Ara Institute of Canterbury, have been delivering cookery programmes since the 1970s. Currently, programmes range from Level 2 Supported Learning, Level 3 Youth Guarantee, Level 4 Certificate of Cookery and Certificate of Baking through to the Level 5 Diploma of Cookery and Patisserie, as well as delivering a number of short courses.

Ara Institute of Canterbury aims to provide programmes and courses that are easily accessible and delivered flexibly. The Institute also works towards maximising the use of online learning platforms for student resources. The Level 5 cookery tutors redeveloped their programme resources to be totally online using the Learning Management System (LMS), Moodle. Additionally, no hard copies of notes or recipes were provided for the students and learners uploaded their portfolios to Mahara, an online e-portfolio system, for marking. The Level 4 cookery tutors continued to use printed workbooks for the 2016 academic year. Assessments, including practical assessments, and written portfolios continued to be submitted at the end of each module as a hard copy.

Feedback from the Level 5 Cookery tutors was that the Moodle LMS was “clunky”, not easily navigated by students and lacked flexibility in its layout. Many of the students used it as little as possible. However, the benefit of having all resources online was that tutors could change and update materials, such as recipes, quickly and easily, adapt them to meet learner needs, make changes to the products based on availability, and also correct any mistakes. In 2017, the Level 5 programme was delivered through OneNote Class Notebook.

At level 4, the assessment portfolio required students to prepare a scrapbook of specified dishes from each practical session. Dishes prepared in class were also evidenced within the scrapbook with photographs of the actual dish produced and feedback on the dishes from the tutor and their peers were to be recorded. The scrapbook also included details on how the dish was prepared, research on the origins of the dish, a self-assessment and critique of the dish, a reflection on the learners' own processes and techniques, and a comparison of the presentation and taste of the final dish.

## The challenge of teaching students how to taste

Everybody eats; therefore it is assumed that everybody ‘tastes’ and therefore that everybody can describe what they are tasting (Perullo, 2016). However, in reality, there is little literature on teaching others how to use their senses to analyse the taste of food (Perullo, 2016). There is an expectation that cookery students would be able to taste a steak and instantly describe it as juicy, or dry, and identify if it needs more seasoning. These were skill an experienced chef would be able to instinctively achieve.

## Rationale

The New Zealand Qualifications Authority outlines the Graduate Profile for the New Zealand Certificate in Cookery (Level 4), which includes:

- *“Apply cookery skills to prepare, cook and present a range of cold larder dishes employing complex preparation and presentation techniques.”*
- *“Apply cookery skills to prepare, cook and present a range of hot kitchen dishes employing complex preparation and presentation techniques.”*
- *“Apply cookery skills to prepare, cook and present a range of patisserie and desserts employing complex preparation and presentation techniques.”* (NZQA, 2017).

Previously, the part of the evidence required to meet the above competencies was the student’s personal tasting notes in their workbook and a photo of their completed dish, and along with the tutor’s dish for comparison. Students then used their notes and photos to prepare their portfolio. The tutor’s expectation was that after class, the students would type up their notes from the day’s lessons and transfer the photos correctly into the template provided. The reality was that students either had work or other activities and duties to complete, or had busy social lives, and therefore waited until a few weeks later when the scrapbook was due to be submitted (usually at the end of term). Additionally, the kitchen environment can be loud, busy and full of aromas; the teaching techniques used included live and videoed cooking demonstrations as the cookery students preferred the activity of the kitchen to the traditional lecture theatre. The students are learning through multiple mediums including through tutor demonstrations, video and recipe books (Nordby et al., 2017) and can customise how they record their notes.

The majority of learners used their smartphones to take photos of their dishes, which was useful for recording the dates on which the dishes were prepared. However, they wrote their notes up in their workbook during the practical lessons as they involved cooking, washing and cleaning; the students therefore avoided bringing larger devices, such as tablets or laptops, into the kitchen.

To assist students to become more efficient recording their dishes and synchronously critiquing them in each practical lesson, a study was undertaken to identify whether using a smartphone to record these events would be beneficial.

The benefits of using a mobile device include the opportunity to use a range of multiliteracies. These include video recording, watching video clips, sharing

information on social media such as Facebook, typing notes, handwriting with a stylus, photographing, translating and voice recording. The massive range of mobile applications allows students to choose those that work best for their learning style/s and gives them ownership and control of their learning (Cochrane, 2010). However, unless learners have identified their preferred learning style/s, can navigate their mobile device competently and are curious about how they can use their device to improve and enhance their learning, it will be an underutilised resource.

Also, allowing students to use their smartphones during class to record evidence of their dishes, runs the risk of creating distractions, which can be problematic, with the multitude of social media apps available at their fingertips (Nordby, Knain, & Jonsdottir, 2017). However, due to the practical nature of lessons and the demands for completing a number of dishes within the session, the students are very busy. This could be surmised to reduce their ability to become side-tracked by their smartphones.

## **Literature Review**

### Learning how to taste

To describe food requires a level of verbalisation which is dependent on the person's exposure to a wide range of different foods and a large memory bank of experienced aromas and flavours (Lanchester, 2008). Humans eat for sustenance, nourishment, enjoyment and the social aspects of dining; but as a professional chef, there is a separation between eating food for enjoyment and tasting food to serve to a diner. If a person is asked what they think of a dish, the initial response is usually a subjective one, they either like it or they don't (Berridge & Kringelbach, 2013). This is often the same response that a new student of cookery will provide. Therefore, chef training incorporates an objective approach to eating, which is achieved by teaching students to taste food systematically using sensory analysis. The senses that are engaged when eating are sight (appearance and colour), smell and taste (which includes texture and temperature) (Caul, 1957).

### Learning how to integrate digital tools into learning how to taste

To successfully integrate technology as a teaching and learning tool requires appropriate selection of apps, thorough instruction on the features, the opportunity to test and practise using it as directed by the tutor, and an emphasis on how the technology can assist the learner (Sadik, 2008). When technology is associated with a teaching and learning tool, it cannot be assumed that a learner will use it in their own time, either as self-directed learning or for personal use. The learner needs to have linked the purpose for using the technology and the learning benefits which arise from it.

When introducing new learning technologies, learners need time to become familiar and comfortable with the technology (Cochrane, 2010). To assist students to utilise new technology as a learning tool, it is vital for the teacher to incorporate the technology into their lesson delivery (Denton, 2012).

## Research Questions Outlined

The research questions, as informed by the discussion above, were therefore to develop a sense of how students were learning food tasting, their learning reflections and how technology could be used to improve both food tasting skills / vocabulary and the record of learning reflections. The three questions were:

1. What is the best practice for encouraging learners to reflect on their performance?
2. What does sensory analysis of food look like at Level 4 Cookery?
3. How can technology be used in the classroom specifically to support the learning of sensory analysis of food?

## Research Methodology

Two groups of L4 Cookery students were chosen to participate in the sub-project. Selection was based on matching the availability of the students to that of the researcher and the willingness of Cookery tutors to work with the researcher, to undertake activities and to allow the researcher to observe their classes.

Each group was briefed on the purpose of the sub-project, the process involved and how data would be collected. Students were asked to sign a consent form in the knowledge that they could withdraw from participating at any stage.

### Data Collection

To establish the student demographics of each group, a short Microsoft Forms questionnaire was created and emailed to individual students. Adjustments were made to the questionnaire for the second group, based on identifying a need for slightly different information.

A Microsoft Forms questionnaire was also used to collect information on how participants made use of their mobile devices. The primary reason for using an online questionnaire was to demonstrate the use of online tools; the mode of questioning seemed appropriate for mobile devices. To attract a high number of responses, the survey was set up so that participants' responses were anonymous, questions only required check box responses and the survey would take less than five minutes to complete.

Data were also collected through observations of students during practical classes, feedback from the students on how they utilised the mobile app (available on both Android and IOS platforms) during practical kitchen lessons and how they transferred their recordings to their e-portfolio.

At the completion of the study, a focus group with the students was also conducted.

## Ethical considerations

Participants require confidentiality and anonymity when participating in surveys and focus groups, particularly information about their assessment performance and results. Personal identifiers will be stored separately from the recorded and transcribed interviews.

## Findings

Findings are summarised from observations carried out whilst students were engaged in kitchen work. These sessions usually involved tutor demonstrations of cooking techniques, followed by students cooking the dish/es.

## Students' learning resources

### *Non-digital*

Every workbook issued to learners (four workbooks over the course of the year) included tasting wheels with descriptive words for each area of sensory analysis (see figure 1). The workbooks were a vital resource; they contained the recipes for each session and the instructions for making the individual dishes. Therefore, students had access to the “specific language of the trade” (Parkinson et al., 2017). However, most learners appeared to be unaware of the tasting wheel's existence as it was situated at the end of each workbook.

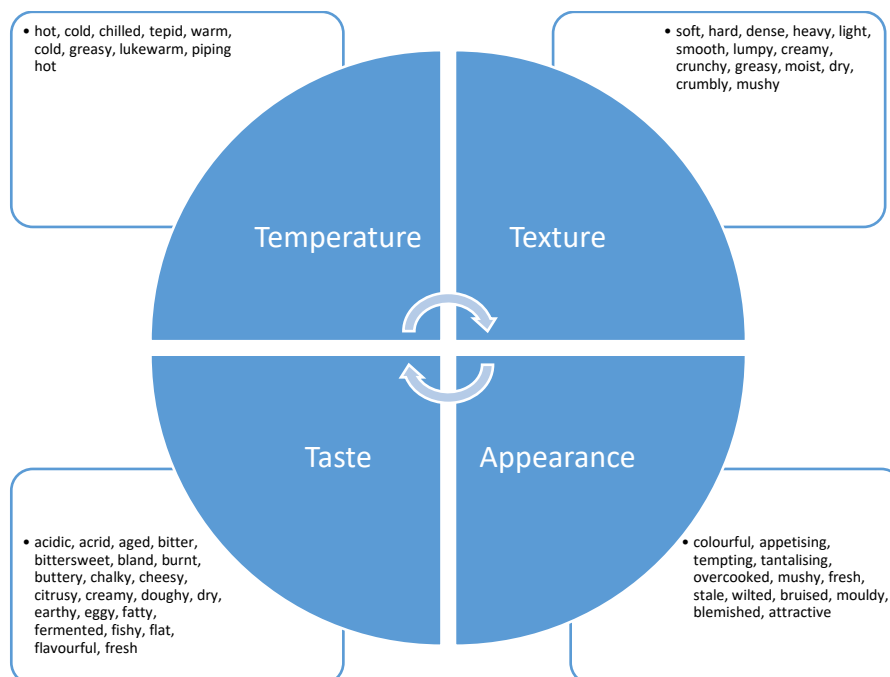


Figure 1: Flavour description 'tasting wheel' used in the L4 Cookery programme

## Learning how to taste

One activity undertaken with both groups required students to match a range of descriptive words with different sensory analysis categories, for example, appearance, temperature, aroma, texture and taste. This prompted discussion



between students and tutors about words with more than one meaning. Examples included defining the differences between food which was bland in appearance against food which was bland in taste. Concepts like an 'eggy' taste were also discussed. The tutor used an example from a previous practical class, where the sauce was cooked out, so it would not taste eggy.

The eggy example was then used as a learning activity with the students. They created a mind map using the Mindly app on their smartphones, adding the words they had categorised. When asked after the session, only two students stated they preferred to use paper and pen to create the mind map.

At the beginning of the course, feedback was sought by the tutor on dishes. At the beginning, students were reluctant to express their own opinions and had difficulty explaining why they liked or disliked a dish. The tutor would continue to probe for more information about their thoughts on the saltiness and/or sweetness of the dish. However, learners were reluctant to give their opinion, and instead waited for the tutor's feedback. The tutor's feedback also included presentation, e.g. comments about the colour and size of the croutons, as well as temperature of the soup.

#### Digital note taking

Only one student was observed making handwritten notes in their workbook, next to the relevant recipe, immediately after receiving feedback from the chef and a peer. Some students wrote notes on paper separately, later in the lesson, as they stated it was faster than typing on a phone and they could categorise their notes by recipe. Hardcopy was considered more efficient by students when it came to collating their scrapbook (assessment portfolio) at the end of the term. No student used a phablet or tablet with a stylus, which the tutors thought would be an easier way to record notes in the kitchen environment.

#### Portfolio evidence collection and collation using digital tools

The organisation and categorisation of learners' photos and notes in preparation for their portfolio was a huge task because students stored their documented evidence in a variety of areas. Learners had to check their timetables for the date of each topic and then match them to the dates the photos were taken, before they could start their portfolio collation. It could take up to an hour to just match up the topics and dates for the whole term before portfolio collation could take place. One student went home and reflected on the lesson from that day and used a memo app on her device. She was an international student and I asked her if she wrote her own notes in her own language, she stated she wrote in English.

One student made the comment that students do not write notes on their phone as the tutor may think they are texting. A concern for students was losing their phone and so they avoided storing notes on it, as generally they do not backup their data. I also asked if she had thought about using a cloud-based app/platform that she could access from multiple devices to store information on as this would that encourage her to record notes on her phone. However, the student had not thought of this process.

One student filmed the tutor explaining processes to the class. She used this for her personal use and did not share with anyone. She found it useful to watch before practical assessments, but it did take up a lot of memory. She had not considered uploading to cloud storage to mitigate this.

The second group had had training sessions on the use of Google Keep and Google Docs, so learners had been using it to take photos and they seemed very comfortable with the apps. During practical lessons, students were not actively taking photos and videos until they were reminded to do so. However, those that did take photos, recorded them with ease. Only two students utilised the voice recording option on Google Keep that converted voice to text and they could play it back. Some students were too embarrassed to use the voice recording feature of the app, despite the tutors' efforts to relax them and even suggesting they go into a storage room for privacy if they wanted to.

Feedback from tutors was that the standard of portfolios had not improved from previous cohorts using standard teaching methods. However, tutors realised they needed to access student portfolios several times before summative assessment. This would allow for formative feedback opportunities prior to receiving the summative assessments.

Google Docs has a feature that allows sharing with others. The shared documents could then be edited or comments added. This was ideal for tutors to look at student scrapbooks and make comments on their writing. The downside for tutors was that due to the Institute aligning with Microsoft, accessing Google Docs required them to use their personal Gmail accounts.

Students preferred using Microsoft Word for collating their scrapbooks, rather than Google Docs, even though the applications are very similar. Learners utilised Google Docs to drag photos into the scrapbook template (along with any tasting notes they had made), and then converted it to a Word document. This meant that the tutor was unable to access student work.

## **Discussion**

A need to focus not just on cooking but how to cook and taste

To encourage Level 4 Cookery students to reflect on their performance during practical sessions requires lesson design that allows for tutor-facilitated reflection time, where the learner is able to record their experiences and critique each dish. In a lesson that involves four or five separate dishes, reflection time needs to be at the conclusion of plating up each dish.

Can a learner realistically recall the nuances of a dish with detailed tutor and peer feedback several weeks after the lesson and give the reasons why their dish tasted the way it did? Considering the number of dishes prepared in class over the course of a term, it seems like an impossible task, but is the approach that learners usually take. Taking a dish home, reheating and tasting it will not produce a synchronistic, analytical experience, as the quality of the dish will deteriorate through the storage, delivery and method of reheating.

Effective reflective practice requires scaffolding from the tutor by providing the key questions for students to answer. There appears to be misunderstanding and misconceptions by learners as to the richness of information required in a "critique" of a dish; many learners assumed that stating a dish "tasted good" was an acceptable description for their portfolio. Therefore, there was confusion amongst the students on the differences between the critique and the reflection. Learners were frequently explaining what they would do differently in the critique section of the scrapbook template, instead of in the reflection section.

To assist students to understand better, the differences between critique and reflection on learning, an activity was carried out. This group of learners were given sample scrapbooks that been assigned different grades: an A grade, a C grade and a D/E grade. Students in pairs were asked to mark the samples using the portfolio marking schedule and rubric. They were very methodical and generally accurate with their grading. Based on the observations and feedback from the students about the samples, the tutor felt that progress had been made. However, when the submitted scrapbooks were marked, the standard of the assessments was still low. Was the standard low due to the timing of the grading activity being too close to the submission date? Students may not have enough time to check and adjust their scrapbook. Did learners not realise that the activity was linked to the tutor's expectation for their own work? Or, were the students hoping that their work was enough to achieve a C grade? The benefit of this exercise for the tutor, was the realisation that they needed to provide an opportunity for formative feedback on the portfolio itself, rather than just on the scrapbook contents, before the assessment due date.

Allowing comparative tastings of student dishes within the practical lessons would highlight variations. Ideally, this would allow learners to identify consistent benchmarks for appearance, aroma, taste, texture and temperature of dishes. For example, asking students to taste dishes with seasoning variations and selecting the correct benchmark. Asking learners to critique in small groups or pairs would provide valuable learning experiences in discussing their personal preferences and establishing agreed benchmarks. However, the course content in its current state is very busy with an emphasis on cooking. Lesson plans will need to be revised to allow for greater emphasis on learning how to evaluate dishes.

#### Timing of learning events and assessments

The summative assessment comes too late for the learner to improve their vocabulary and reflective practice, so utilising software and apps that allow the learner to share their documents with their tutor for formative feedback on their progress is of benefit.

An activity was undertaken with learners to create a tasting mind map using the Mindly app (available on both Android and IOS platforms), where learners had to categorise various descriptive words relating to taste as provided in the tasting wheel in their workbooks (see figure 1) The characteristics to be evaluated include Appearance, Aroma, Temperature, Taste and Texture. The descriptive words of vocabulary for each category was taken from the tasting wheel in their workbooks (see figure 1 above). However, tutors appeared surprised when feedback from the learners stated that they were unaware the tasting wheel existed. Would having an app containing the vocabulary on their phone help improve their sensory analysis? Unless students are instructed to use an app, they are highly unlikely to use to it, much like the situation with their workbooks.

Cookery vocabulary and the process chefs instinctively use when tasting (similar to that of wine tasters), where they automatically analyse the appearance, then the aroma and then the taste, needs to be incorporated into lessons as early as possible and the steps need to be followed in the same order each time. This would be particularly helpful for students with English as a second language, who are not confident with expressing their opinions about their dishes.

## Recommendations

Several recommendations were derived from the data and research reflections. These have been matched to the research questions (RQ) for the study. The recommendations are:

- Tutors should follow a repetitive, systematic approach to tasting food, as occurs with wine tasting, appearance, aroma, temperature, texture and taste (RQ1 & RQ2).
- Each lesson (or part of a lesson) should finish with a taste comparison of the dishes made by the students. Students should identify the degree of flavouring and seasoning, similarities and differences in taste between the dishes, benchmark dishes, and practice developing consistency between students when tasting (RQ1 & RQ2).
- Tutors need to allow a reasonable amount of time for tasting during practical lessons, so that dishes are tasted as they would be served. This would allow the students to experience the dish under the right conditions, rather than tasting cold or reheated dishes which adversely affects the students' sensory analysis (RQ1 & RQ2).
- Allow students to taste dishes collaboratively and discuss dish preferences. Students may have food intolerances, or may, for religious or personal reasons, or not be able to taste all dishes. Listening to the way other students talk about the flavours would resonate more than reading a written tasting note (RQ1 & RQ2).
- Scaffold the specific language of the trade (see Parkinson et al., 2017) by applying key vocabulary that is embedded into practical lessons and recapped on a regular basis (RQ1).
- Deadlines for scrapbook submissions need to be made explicit to learners, so tutors can provide formative feedback before students submit. It would reduce student stress due to having to submit the assessment in small chunks throughout the term and would also assist students' literacy improvement (RQ1).
- Tutors need to role model the use of devices in class and actively refer to the apps that are to be utilised. Tutors should record their own dishes through the selected app (including using the voice recording app). Further efforts to encourage learners to use the voice recording feature of Google Keep would enable faster and easier documentation of dishes during practical lessons (RQ1 and RQ3).
- Students should be encouraged to purchase a device that has a stylus, e.g. a tablet or phablet. The phablet may be more desirable in the kitchen environment, as it should fit into the learners' trouser pockets (RQ3).
- Investigate opportunities for training students to store their scrapbooks as Word documents in OneDrive, so that they can be shared with tutors, to enable formative feedback (RQ1 & RQ3).

## References

- Berridge, K. C., & Kringelbach, M. L. (2013). Neuroscience of affect: brain mechanisms of pleasure and displeasure. *Current Opinion in Neurobiology*, 23(3), 294-303. DOI: <https://doi.org/10.1016/j.conb.2013.01.017>
- Caul, J. F. (1957). The Profile Method of Flavor Analysis. *Advances in Food Research*, 7(1), 1-40. doi: [http://dx.doi.org/10.1016/S0065-2628\(08\)60245-1](http://dx.doi.org/10.1016/S0065-2628(08)60245-1)
- Cochrane, T. D. (2010). Exploring mobile learning success factors. *ALT-J: Research in Learning Technology*, 18(2), 133-148. DOI: [10.1080/09687769.2010.494718](https://doi.org/10.1080/09687769.2010.494718)
- Denton, D. W. (2012). Enhancing Instruction through Constructivism, Cooperative Learning, and Cloud Computing. *TechTrends*, 56(4), 34-41. DOI: [10.1007/s11528-012-0585-1](https://doi.org/10.1007/s11528-012-0585-1)
- Lanchester, J. (2008). Scents and Sensibility: What the nose knows. *The New Yorker* (3 March 2008), 84, 120.
- Nordby, M., Knain, E., & Jonsdottir, G. (2017). Vocational students' meaning-making in school science—negotiating authenticity through multimodal mobile learning. *Nordina*, 13(1), 52-65. DOI: <http://dx.doi.org/10.5617/nordina.2976>
- Parkinson, J., Coxhead, A., Demecheleer, M., Mackay, J., Matautia, L., McLaughlin, E., & Tu'amoheloa, F. (2017). The Language in the Trades. <https://ako.ac.nz/knowledge-centre/the-language-in-the-trades/the-language-in-the-trades-education-2017/>
- [Perullo, N. \(2016\). Taste as experience: The philosophy and aesthetics of food.](#)  
New York, NY: Columbia University Press.
- Sadik, A. (2008). Digital storytelling: a meaningful technology-integrated approach for engaged student learning. *Educational Technology Research and Development*, 56(4), 487-506. DOI: [10.1007/s11423-008-9091-8](https://doi.org/10.1007/s11423-008-9091-8)
- The Open University (2012). Being Digital: Digital literacy skills checklist. Retrieved 5 April, 2018, from <http://www.open.ac.uk/libraryservices/beingdigital/accessible/accessible-pdf-35-self-assessment-checklist.pdf>

## Role-play/simulations in aeronautical engineering utilising reflective and problem-based learning and learning from errors



James Gropp and Aaron Lyster

### Introduction

This qualitative study involved students enrolled on the NMIT level four Certificate in Aeronautical Maintenance Engineering programme who were in their final in-residence phase of a two-year programme. The students were participating in the fixed wing and rotary wing aircraft servicing phase requiring the completion of maintenance activities similar to those performed in the aviation industry. The students were provided with guidance on reflective and e-portfolio evidence gathering processes to enable them to begin the trial. The aim of this study was to determine if problem-based learning (PBL) methodologies combined with reflective practice would improve students' learning outcomes. Learning was 'recorded' by students through the use of e-portfolios. The major activities during the study revolved around the students' ability to learn from their mistakes through reflection and self-analysis. This approach has been shown to help students with low prior subject knowledge increase and "repair their understanding" of the topic (Mason et al., 2016). Student reflective practice techniques were documented in an e-portfolio.

The PBL process requires students to utilise their metacognitive skills. Firstly, reflective practices are encouraged to help students ascertain their current knowledge levels regarding the problem or task they are trying to solve. Secondly, the development of critical thinking skills which is reliant on the students' ability to monitor their own knowledge levels and to undertake measures to improve their thinking and learning processes (Halpern, 1999). Thirdly, through reflection on their reality-based scenarios, students learn to engage the critical thinking skills required to solve problems. Students who can learn critical thinking methodologies, can then apply these skills across a range of domains (Halpern, 1999).

The development of problem-solving skills is further enhanced by leveraging off the meta-cognitive skills development that results from the documentation and reflection of their learning in their e-portfolios. This correlation has been highlighted by previous research (Halpern, 1999) (Hmelo-Silver, 2004) (Kolb, 1984) (Knowles, Holton, & Swanson, 2011).

### Student Test Group

Eleven students aged between 20 and 37 years old took part in the study. The student test group was comprised of one international military female student, five international military male students, two international civilian male students, and three domestic male students. See Figure 1 for the age distribution, and Figure 2 for the domestic versus international breakdown.

Figure 1. *Student test group age distribution*

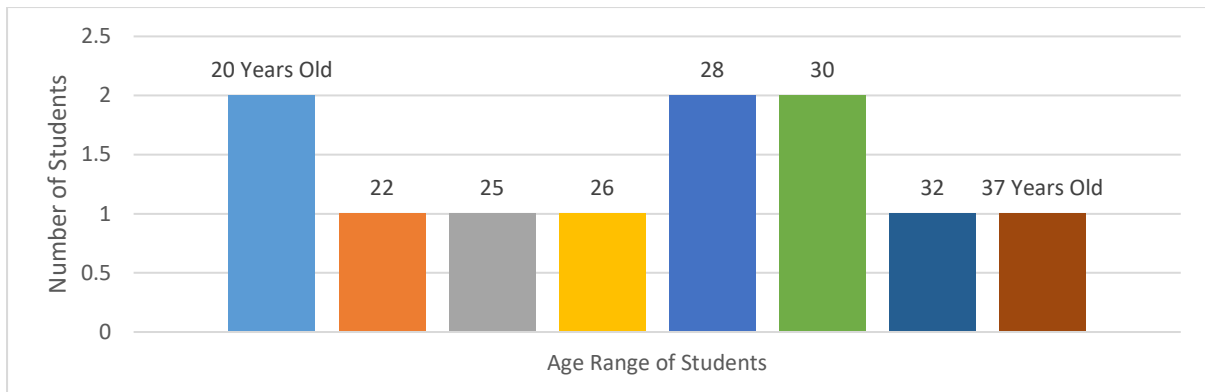
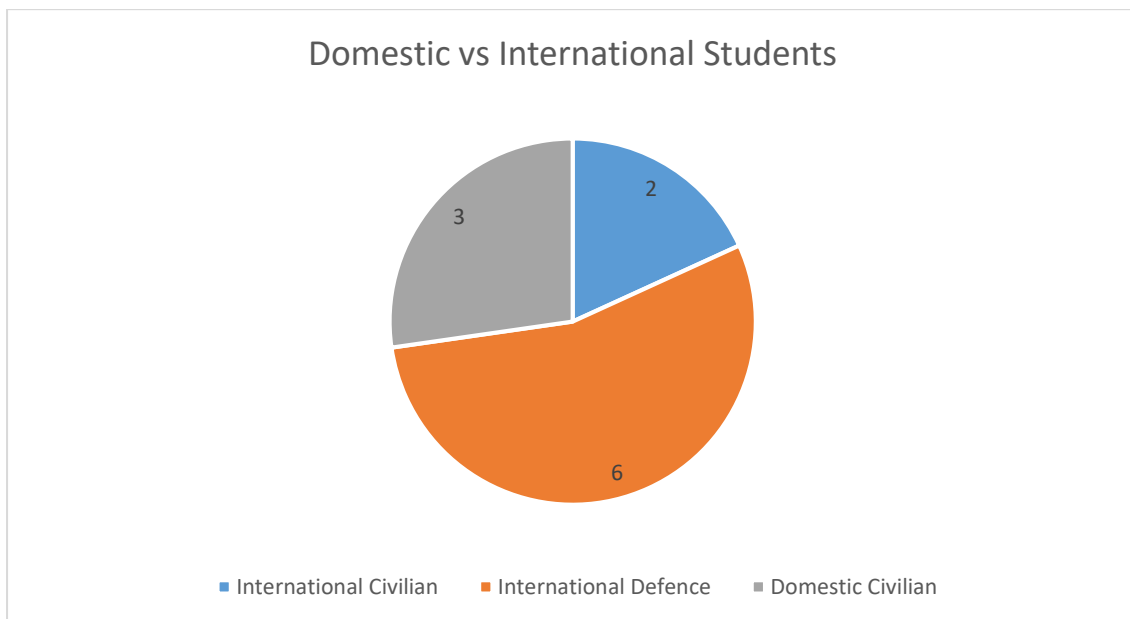


Figure 2. *Domestic versus international breakdown*



All students who took part in the study were senior students. These students had previously passed the nine pre-requisite courses to enrol in the two servicing phase courses, where the study took place. Foundational knowledge of aeronautical engineering was attained by students through completion of the pre-requisite courses.

Voluntary permission was obtained from all students in the study with the signed authorisation forms held on file. Ethical considerations were taken into account surrounding the subjects taking part in the study. Approval was gained from both ARA and NMIT institutions' academic boards and research/ethics committees.

### Methods Used

This qualitative study utilised the participative action research (PAR) approach which forms part of a larger study. In the study reported here, participating students performed learning activities in line with Kolb's experiential learning process (Kolb, 1984). This process also involved a tiered learning approach which allowed the students to leverage off their current experience, observe and reflect on that experience, formulate strategies and plans to address the learning task, and trial those strategies/plans in the workshop (Knowles et al., 2011). This methodology of

learning aligns with the generally accepted problem-based learning model's key features (Dochy, Segers, Van den Bossche, & Gijbels, 2003). Students in the study followed the PBL process to solve the aircraft servicing tasks they were required to complete in order to achieve the relevant NZQA unit standards (Hmelo-Silver, 2004). See Figure 3 for an outline of the PBL process.

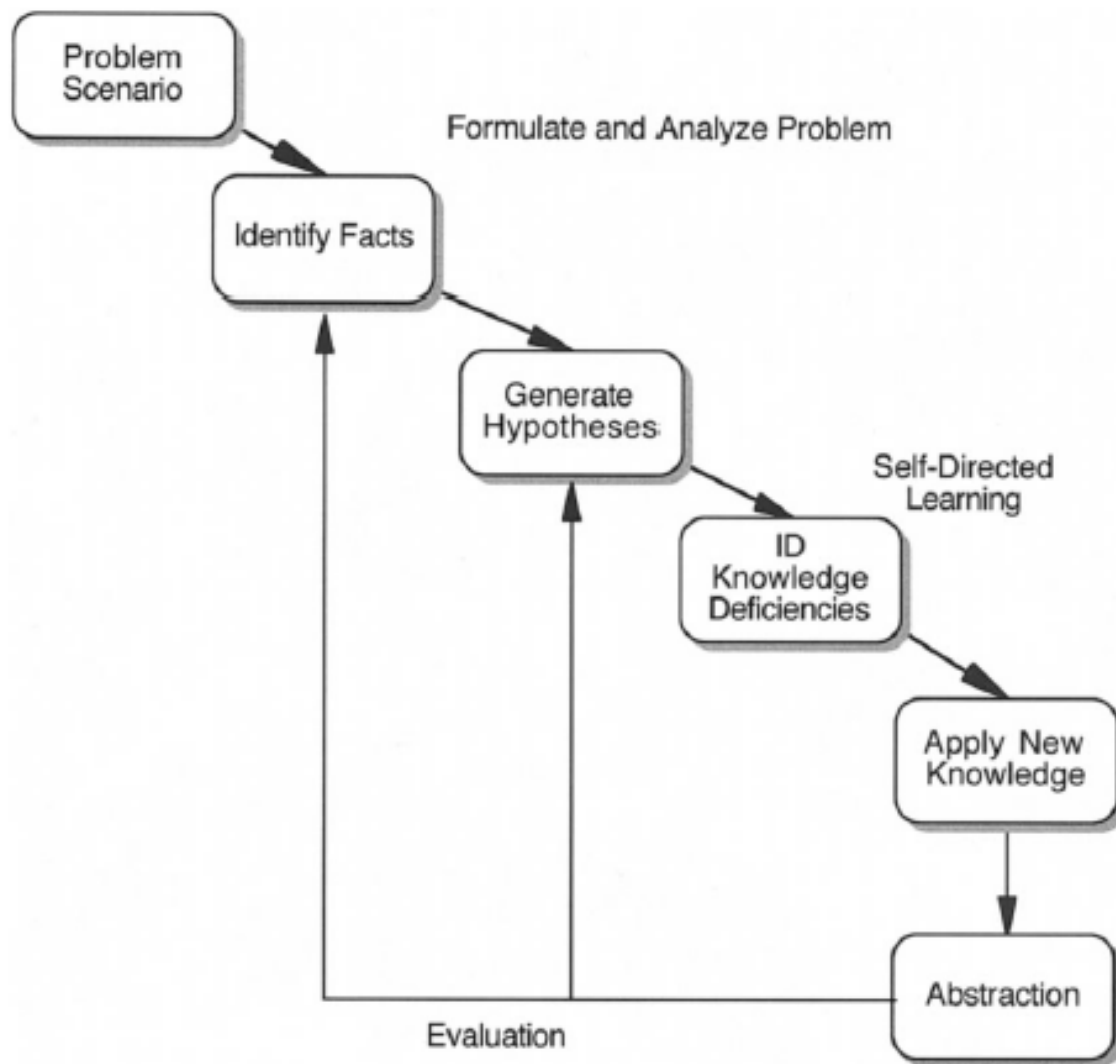
The purpose of the PBL methodology used in this study was to help develop the students' understanding of the specific subject matter knowledge required to accomplish the tasks within the context of the aviation industry. This approach was chosen to improve students' critical thinking skills in an effort to improve their decision-making skills as they relate to real-life problems. The PBL method in this study was a blend of immersion and infusion critical thinking instructional approaches where the task design inherently had critical thinking skills embedded (immersion) while the PBL and reflective instruction focused more directly on critical thinking skills in isolation from the topic (infusion). This is based on the PBL activities, small group discussion, role playing, coaching and tutor modelling, that was undertaken within the study (Tiruneh et al., 2017).

Evidence was gathered during the study by means of instructional tutor observations, independent senior academic tutor observations, student learning conversations and anonymous feedback questionnaires. The authors wish to acknowledge the following biases:

1. The authors' professional relationship with the study's subjects could potentially affect their objectivity regarding particular student observations.
2. The authors' 'pride of authorship' of course material poses the potential for subjective content interpretation.



Figure 3. *Problem-based learning process*



(Hmelo-Silver, 2004)

### First PAR Cycle

The first PAR cycle was task focused. The students completing the assigned aircraft servicing tasks documented their learning journey before, during and after the task in their e-portfolios. The tutor's traditional theory instructional time was utilised for providing the students with the necessary knowledge to set up and use Microsoft OneNote as their e-portfolio. Once the OneNote profiles were established, the students moved on to the practical tasks. During this initial phase, students had the reflective PBL process explained to them.

Initially, student verbal feedback suggested they were finding it difficult to engage with the e-portfolio and reflective practice, with several students experiencing device and access issues. Some students commented that they found it difficult to 'see what was in it for them' and felt that it slowed down completing the task. Students were observed by the tutor 'cutting and pasting' information from their pre-task reflections into the 'during' and 'post' task reflections within their e-portfolios. Additionally, the depth and breadth of information initially recorded by the students

was minimal and demonstrated a neutral to negative attitudinal approach to the method. This behavioural reaction could be linked to multiple causal factors, but it aligns to the argument of a demonstrated low level of critical thinking skills, indicating a lack of metacognitive ability relative to the subject and the process (Halpern, 1999). This assumption is based on the PBL model used in the study meeting the criteria for a 'powerful learning environment' as outlined by Dochy et al. (2003).

First, the PBL was student-centred. The learning revolved around the student. Second, the PBL was undertaken in small groups under the guidance of a tutor. Third, the tutor acted as a facilitator instead of a lecturer. Fourth, authentic problems were encountered *before* the learning took place. Fifth, the problems were used as a mechanism to achieve the required knowledge. Sixth, the new information was acquired through self-directed learning. And finally, the students learned by analysing and solving problems (Dochy et al., 2003).

Based on the initial observations and student verbal feedback, the tutors felt the poor student engagement was based on the following factors. Firstly, students appeared to not understand the need to know aspects of the exercise. They did not attach value to the reflective practice within the problem-based learning tasks. This conclusion is supported by the assumptions outlined in the andragogical model, specifically, the 'need to know why' assumption. It is understood adults need to attach value and understanding of why they need to learn something before they will invest effort into learning it. Additionally, adult learners' readiness to learn is directly linked to their ability to apply the learning to a real-life situation, as identified in the andragogical model's fourth assumption (Knowles et al., 2011). These observations align with Halpern's (1999) research aligning the critical thinking skills to the metacognitive abilities of students.

In the first PAR cycle, the students were more task-focused than learning-focused. With some students working collaboratively in groups, their focus was on completing the task and not on their learning journey during the completion of the task. Tutor observations and interactions with the students, identified that the students demonstrated a distinct lack of reflection on their mistakes, with their sole focus being on task completion. The first written feedback identified that students liked the ease of use of OneNote and the ability to write down what they had completed during the task. Some students commented that it was a good review of what they had accomplished, as well as a memory 'jogger'. Only one of the students commented that it was a good reflection tool to look at what they had done wrong and learn from those mistakes. This feedback supports a distinct lack in the application of critical thinking skills as discussed by Halpern (1999).

When asked what would improve the process, one student commented that it would be better for each student to complete their task sheet individually, with tutors guiding them with ideas and knowledge. Another student commented that putting in more pictures and writing more detail about a task would improve the process. What became very evident was the students' focus was not targeted at the objective of using reflective practice to learn from their mistakes. This relates to a failure in the 'preparing learners' element of the andragogical process, whereby participation preparation and expectations about the content are established (Knowles et al., 2011). See Attachment 1 to view the first task sheet.

From the evidence gathered in the first PAR cycle, it was decided to make a minor change to the wording on the task sheets to better align the students' focus to the intended learning activity and outcomes of the trial. Additionally, the emphasis on

what the students should capture and focus their efforts on was changed from the actual task the students were performing to the learning that occurred during the task. Special emphasis was placed on the mistakes or incorrect assumptions and decisions that had occurred during the task. This was actioned in the workshop by the tutor focusing their actions, instructions and guidance toward the learning reflection (infusion-based instruction) (Tiruneh et al., 2017). See Attachment 2 to view the adjusted task sheet. The adjustments were aimed at helping improve student engagement with the PBL method by bolstering the 'preparing learners' aspect of process (Knowles et al., 2011).

### **Second PAR Cycle**

After the task sheet adjustment to incorporate the identified changes, the tutor initiated the next PAR cycle. The tutor modified the guidance and direction to the students by asking open-ended questions to support the students' reflection on the learning that occurred in the tasks (immersion-based instruction) (Tiruneh et al., 2017). This would help correct the student's focus from task- to learning-centric. Tutor facilitation was identified as a potential problem area if the PBL reflective practice method was to be integrated throughout the aviation school. It is recommended that professional development that includes modelling the techniques required to deliver reflective PBL be developed and delivered to the academic staff.

Tutor observations were carried out by a senior academic staff member during the second cycle. Student verbal feedback indicated students' focus had changed from the first PAR cycle. They were now actively looking for and recording their mistakes with the aim of learning from them, not repeating them. The depth of e-portfolios improved marginally with some students taking great pride in recording their information and reflecting on their performance. It was noticed that the course tutor and tutorial assistant were facilitating the learning environment and not acting as the subject matter experts. This demonstrated approach aligns with Dochy et al.'s (2003) model of PBL which places the tutor as the facilitator and the students at the centre of the learning with the new knowledge being gained by self-directed learning.

Student feedback supported the shift in focus from the task to learning from their mistakes, with many of the students' comments supporting this observation. With the successful outcomes of the second PAR cycle, the decision was made not to adjust anything and allow the third PAR cycle to run 'as is'. Allowing students to perform the same process in the third PAR cycle without any changes would provide insight into how the student's learning would be affected once they were more familiar with the PBL reflective process as highlighted by Tiruneh et al. (2017).

### **Third PAR Cycle**

The third PAR cycle consisted of students undertaking additional aircraft servicing tasks utilising the same methods as they did in the second PAR cycle. From an external observation perspective, the students appeared very self-directed, motivated and focused, a key feature of PBL (Dochy et al., 2003; Knowles et al., 2011). Tutor and tutorial assistant interactions were on a 'teaching by questioning' basis.

This approach facilitated an environment of problem-solving, research and discovery that aligned with relevant theory (Dochy et al., 2003). The majority of the students appeared confident and capable of being self-sufficient with the process and the use of the e-portfolio. It was evident that the repetitive exposure to the reflective e-portfolio approach enabled students to work faster and more efficiently with a heightened awareness of the need to reflect on their mistakes and learn from them. From a learning perspective, the tutor was able to review the students' e-portfolios and gain valuable insight into the level of student comprehension and learning. Additionally, it proved to be a substantial body of assessment evidence to support the award of NZQA unit standards.

The student feedback showed that students were taking a more active part in improving the process. Students provided suggestions on how to make the process better for them as learners. This feedback suggests the students were starting to take ownership of their learning process.

## Results

Student survey results looked at two primary areas of focus, the effect of the task sheet (practical based) and the effect of reflective practice (meta-cognitive based). When asked how well they felt the task sheet helped them accomplish the task, 70% said it helped a lot (post 1<sup>st</sup> cycle), whereas 63% stated the same response after the third cycle. However, the perceived benefit of the task sheet for the students did not appear to change over the course of the study. Similar results were observed when students were asked how well they felt the task sheet helped them as a learner, with 70% saying it helped a lot after the first cycle, and 72% saying it helped a lot after the third cycle.

When analysing the survey results for the meta-cognitive aspect of the study, a different response pattern emerged. These survey questions were supplied to the subjects after the change in approach was made after PAR cycle one, which addressed the focus of the students onto learning from their mistakes instead of task completion. The students felt learning from their mistakes and reflecting on them helped them prepare for their next task. This aspect was evidenced by 80% of the students' responses stating 'it helped a lot', while 20% said 'it helped a little' (post second PAR cycle). Comparing this to the survey administered post third PAR cycle, 90% of students said it helped a lot versus only 10% stating it helped a little.

When asked how well they felt that learning from their mistakes and reflecting on them helped them as learners, 70% of students said it helped a lot with 30% stating it helped a little (post second PAR cycle). Comparing this with the post third PAR cycle where 90% said it helped a lot and only 10% said it helped a little. It is worth noting that at no point did any student respond 'it didn't help' to any of the questions.

The authors suggest that these results show growing awareness of students' meta-cognitive abilities and increasing importance being placed on their critical thinking. The demonstrated increase in value that the students placed on the reflective practice spanned across the practical and meta-cognitive domains.

## Summary

We believe the results from this qualitative study support our hypothesis that PBL promotes critical thinking skills and therefore improves student learning outcomes. The students in this study demonstrated an increasing trend in their engagement, reflective practice and self-management of their learning. This was evidenced by the utilisation of their e-portfolio in OneNote and tutor observations. The learning outcomes achieved by this trial would suggest the students who were exposed to this learning method from the start of the two-year programme, could reach exceptionally high levels of self-reliance and reflective practice by the end of the programme. These results support Tiruneh et al.'s (2017) research suggesting that both immersion and infusion instructional methods help develop meta-cognitive skills.

The students' efforts in recording their mistakes, and what they had learned from those mistakes, would more than meet the evidence requirements for award of the multiple unit standards within their programme of study. Their task worksheets would bolster their portfolio of evidence from the technical perspective and add to the support of awarding the unit standards. This result supports the assumption that the learning outcomes for the students in the study were at least as good as those taught by traditional instructional methods. We suggest that the learning outcomes for the students in the study were improved versus the school's traditionally taught students given the demonstrated improvement in their critical thinking skills. This suggestion is based on circumstantial evidence comprised of experienced tutor observations, staff discussions and overall demonstrated abilities of the students.

## References

- Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learning and Instruction, 13*(5), 533-568. DOI: [10.1013/S0959-4752\(02\)00025-7](https://doi.org/10.1013/S0959-4752(02)00025-7)
- Halpern, D. F. (1999). Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker. *New Directions for Teaching and Learning, 80*, 69-74.
- Hmelo-Silver, C. E. (2004, September). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- Knowles, M. S., Holton, E. F., & Swanson, R. A. (2011). *The Adult Learner. The definitive classic in adult education and human resource development*. New York: Elsevier Inc.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ, USA: Prentice-Hall Inc.
- Mason, A., Yerushalmi, E., Cohen, E., & Singh, C. (2016). Learning from mistakes: The effect of students' written self-diagnoses on subsequent problem solving. *The Physics Teacher, 54*(2), 87-90. DOI: [10.1119/1.4940171](https://doi.org/10.1119/1.4940171)
- Tiruneh, D., Cock, M., & Elen, J. (2017). Designing learning environments for critical thinking: Examining effective instructional approaches. *International Journal of Science and Mathematics Education, 16*(6), 1065-1089. DOI: [10.1007/s10763-017-9829-z](https://doi.org/10.1007/s10763-017-9829-z)

## SubTask Code 411-2 Jacking of the fuselageEvidence task sheet

Friday, February 17, 2017 11:42 AM

Pre-task

### Job Description

The Fuselage requires jacking to service the main landing gear

### Publication References used

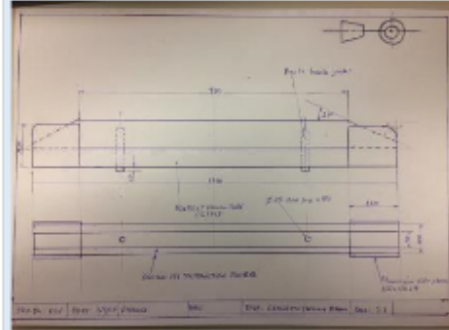
Cessna 150 MIM Jacking  
GEOT tech query 15/03 2

### Safety considerations (SMS)

Safety boots, Glasses and overalls.

Aircraft needs a jacking block designed by engineers to handle weight of airframe.

Insert Photo Here



During task

**During Task considerations/issues, e.g. Special tools, safety, Environment, Aeronautical Process etc...**

### **ISSUE DESCRIPTION (what is the problem/tech query)**

The Cessna requires jacking to enable servicing of main gear, the book requires the fabrication of a lifting block of wood to span across the undercarriage springs and has two jacks used to jack against the wood. Not much information is given in the making of this wooden beam

Jacking Block Design required to enable service of landing gear, MIM dimensions page 2-2 fig 2-2 as attached above ( link to MIM : [Cessna 150 - MIM Service Manual- D138-1-13 \(1962 and Prior\)](#) )

Location of Brake lines may cause issues in placement of block.

The Jacks do not have locking collars so the aircraft cannot be left on them for a significant period of time so a trestle is also being designed by the GEOT engineers.

Jacking block is currently being designed and manufactured. 7th March 17.

Post-task

### What was the Goal of this task ?

To jack the aircraft in a safe manner to service the undercarriage.

### Did you achieve this goal?

Yes, after consultation with the GEOT engineers a jacking block was designed and manufactured. The aircraft was successfully jacked and the next work team will service the wheels.

### If you were faced with the same task again, what would

## Task Code: 410-24 UH-1H Force Trim Functional Check

Friday, February 17, 2017 11:42 AM

### Evidence task sheet

Pre-task	<p><b>Job Description</b> Functional check of the Force Trim</p> <p><b>Publication References used</b> UH-1H Maintenance Manual Chapter 9, Pg9-98 Para9-264</p> <p><b>Safety considerations (SMS)</b> Safety-man posted on the aft of aircraft Knowledge on using external power Co2 Fire extinguisher in case of fire</p>	<p><u>Insert Photo Here</u></p> 
During task	<p><b>During Task considerations/issues, e.g. Special tools, safety, Environment, Aeronautical Process etc...</b></p> <p>Connected external power to the UH-1H, supplying 24v Turned on hydraulic power to allow free movement of flight controls in the cockpit Co-Pilot cyclic stick Trim Tab functional Check found serviceable</p> <p>Issue: Found difficult moving cyclic due to no hydraulic power at first. Force Trim button on the pilots cyclic found faulty, needs to be checked for service, refer to Task Code: 410-25 For the UH-1H</p>	
Post-task	<p><b>What was the LEARNING Goal of this task ?</b> Use of external power and it's correct procedure for turning on and off How the Force Trim works and its function</p> <p><b>Did you achieve this learning goal?</b> Yes/No, Why...</p> <p>Yes, completed the functional check but found fault in the pilot's cyclic</p> <p><b>If you were faced with the same task again, what would you do</b> Research task and prepare all tools necessary for said task</p>	

## Supporting tuākana/ tēina relationships during learning of carpentry skills



### Kym Hamilton

#### [He Toki Multiliteracies report June 2018.mp4](#)

Interviews with apprentices and employers to find out how technology is used during a He Toki apprenticeship.

Included are:

Apprentices' deployment of video to assist with assessments for learning:

- Collection of evidence of learning at work
- Sharing of these videos with peers
- Collation of an e-Portfolio for assessments for learning and CV
- Self-efficacy improvement when others provide feedback and comments on work that is shared.

Employers' perspective:

- Access to evidence of learning as apprenticeship proceeds
- Reinforced need to use technology in the building industry.

Apprentice assessor on how the system works:

- How the evidence 'diary' works
- Provides an on-going evidence of work as it progresses
- Uses photos to provide context of the apprentices' learning
- Evidence helps reinforcement learning and provides a resource for later reference
- Boosts confidence of apprentices to show what they have achieved
- Still using both a paper-based and digital version to ensure learners have equitable experiences.



## Virtual building: assisting carpentry students to attain skills and attitudinal shift in health and safety within building sites



**Kamuka Pati and Allan Warburton**

### **Abstract**

With the need to provide a more immersive and authentic learning experience for students, Virtual Reality (VR) has been identified as one of the important recent developments in educational technology. This report outlines the use of VR in the context of a construction course. The challenge of students gaining experience safely on complex builds is explored and the place of authentic learning in education discussed. Emphasis is placed upon using VR to enhance the student experience and prepare them for the workplace. Creating a mixture of 3D and 360-degree VR content viewed through Google Cardboard or similar devices, this study proposes to identify if the integration of VR does in fact enhance a student's learning experience.

### **Introduction**

The focus of this study is integrating virtual environments into assessment design with the use of VR headsets. Carpentry graduates are exposed to hazards from the first day they enter the workforce and statistics for accidents in the construction industry are, unfortunately, one of the highest. WorkSafe New Zealand (2018) recorded a total of nine fatalities for 2017 and an average of 265 non-fatal injuries and illnesses were reported each month. Traditional methods for engaging new students with health and safety relied on the safety of a class room environment, with images and analysis through paper-based activities. Virtual technology has the potential to

bridge the gap between experiential learning and better prepare students for industry.

In recent years the carpentry staff at Unitec have experimented with emerging technologies and this study provides research into whether new learning technologies provide better learning opportunities. Carpentry students often acquire knowledge best by experiential learning and active problem-solving. However, educating new users to health and safety in a more engaging but safe environment has traditionally been problematic.

## Literature Review

An investigation of the options

The wider construction industry currently makes good use of a range of practical learning approaches to prepare students for the workplace. Yet a gap is apparent between the learning that happens within a relatively safe educational environment and the experiences students have once they set foot on a real-world construction site as an apprentice. De Freitas and Neumann (2009) support the notion of simulation techniques as one way to enhance the current state of education. Technology can provide carpentry students with a more embedded approach that better reflects the needs and challenges they are likely to face once they reach their ultimate goal of employment. Traditionally health and safety are taught and assessed in a theory classroom by using images or paper-based activities and assessment methods. However, there has been a disconnect between theory and practice and this has perhaps been caused by a lack of authentic learning. The realities of health and safety are misrepresented and can often create a false sense of reality of their true nature.

### Immersive Authentic Learning

While simulation is used in many educational situations, it is important to ensure its use is guided by a carefully considered theoretical underpinning. One such framework that supports the use of simulation in education is Authentic Learning. Collins (1991) suggested that for learning to be meaningful, it should be embedded in the same context that it will be used in later professional life (Collins, 1991). This is a fundamental principle of the theory of *situated cognition* or *situated learning* (Brown et al., 1989), a theory that has greatly informed the theory of *authentic learning*. Herrington et al. (2010) contend that “for authentic learning to occur, learners must be engaged in an inventive and realistic task that provides opportunities for complex collaborative activities” (p. 12).

Realism is a critical aspect of Authentic Learning, as a realistic learning experience will be easier for students to translate into later life experiences. Smith (1987) believes that it is important for a problem to be ‘cognitively real’. The most important aspect of a problem simulation is that it promotes a problem-solving process that is realistic. Herrington et al. (2007) reinforce and extend this view as they suggest that immersing students in engaging and complex tasks can provide a cognitive realism that is more important than the reality of the problem. Simulations can play an important part in the learning process, however, they are most effective when combined with real life learning experiences (Galarneau, 2005).

The launch of online virtual world platforms such as Second Life and Active Worlds led to a plethora of research into the use of these platforms in education. Virtual worlds allowed students to interact in challenging scenarios that represented real world situations without the risks and expense that would otherwise be involved. Dickey (2005) illustrates the potential opportunities afforded by virtual worlds for situated, collaborative learning experiences. Significant investigation of the use of virtual worlds has occurred in the health disciplines (Boulos et al, 2007), which also face challenges such as health and safety and cost. De Freitas and Neumann (2009) state that Virtual Worlds offer an opportunity to bridge the gap between traditional teaching experiences and real-life learning experiences. While virtual worlds go a long way towards creating an immersive environment, they are typically viewed through a computer screen, distancing the user from the environment. Herrington et al. (2010) highlight the importance of creating a suspension of disbelief in order to truly immerse the learner in the experience. Current advancements in VR technology have made it more easily accessible and an ideal approach to creating this suspension of disbelief.

### The value of VR in education

VR has been highlighted as an important development in educational technology by the New Media Consortium. They have also indicated that it is particularly relevant for STEM subjects, such as construction (Johnson et al., 2015). To examine the further value of VR in education, one can look at it through a constructivist lens.

Constructivism, based upon the principles of learning being an active process, with learners constructing knowledge, supports the use of VR in education. This is because, within the VR environment, the “user can interact, control and manipulate the state of objects and use specialized tools to create new objects, modify existing ones, and to undergo simulated assessment tasks” (Shehri, 2012, p. 339).

One factor driving the increased use of VR in education is how affordable it is becoming. This increase in popularity creates the benefit of equal opportunities for all students regardless of their age, physical abilities, and gender (Shehri, 2012). This has had the effect of creating a level playing field for all students to access the curriculum. It must also be noted that care needs to be taken with VR. Using VR in the classroom environment does not automatically imply increased student engagement (Huang et al., 2010) nor does it imply that students can readily transfer skills learned in a VR environment to a real-world environment. Consequently, the issue of realism needs to be addressed. In order for authentic learning to occur, the VR environment must provide a “consistency of object behaviour” (Fowler, 2005, p. 413), which readily prepares the student for the world of work and thus making the links more explicit between learning experiences in the VR world and those in real life.

As with other teaching and learning developments, simply by placing a new ‘tool’ into the classroom with limited support does not release the full potential. Therefore, in order to gain the maximum educational benefits from VR, issues concerning teacher confidence and fear of this new technology, as well as integrating VR authentically into teaching courses, must be addressed. With regard to progressing forward, we need to utilise the full potential of VR and not simply use it as a replacement for other tools. As Fowler (2005) argues, VR should not be used to “emulate current practices, but, where possible, to innovate new, pedagogically sound practices” (p. 416).

## The use of VR in this project

To address this problem of authentic health and safety activities, the use of VR headsets was employed. This solution involved several steps and the utilisation of various software programmes and hardware devices. The first step concerns construction staff, using a software programme such as Google Sketchup, designing and creating 3D building models that fulfil learning outcomes and extend the students' learning. The second part of constructing VR material involves the use of a 360-degree camera. Staff would capture photos and videos of various construction sites using the 360-degree camera. The use of a 360-degree camera over a 'normal' camera, has the benefit of capturing the whole site, and adding to the virtual immersive experience of being on-site. A number of example 360-degree videos were captured from different construction sites. This range of examples demonstrates to students the potential work environments they may experience, without them having to leave the learning institution's grounds. A software programme, such as Wonda VR, was used to combine the 3D building models, the 360-degree photos and videos of the construction sites. Wonda VR is a program that is currently being developed to be compatible with Google Cardboard and other devices. Therefore, the view is, students will be able to use their own smartphone and a low-cost headset (such as Google Cardboard) to interact with this VR content. The intention is to allow students to access this material either on campus or anywhere else they choose, allowing flexibility in their learning.

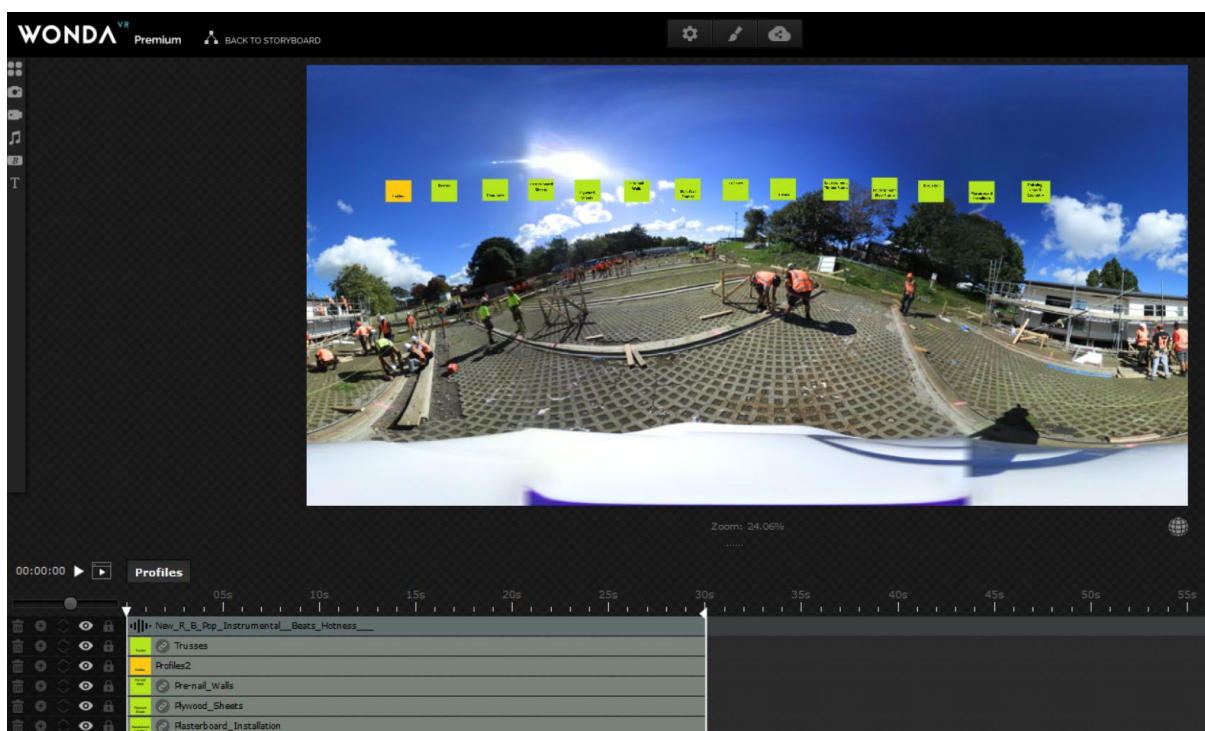


Figure 1: Example of a VR interface developed with Wonda VR

Through the use of Wonda VR, the interactive elements are enhanced. 'Hotspots' are added to the 3D building models to highlight both teaching points and important health and safety aspects on the various construction sites. Previously, this would have been impossible to demonstrate and show students before they entered the

construction site. The students have the ability to walk around and explore the site in an immersive way, building up their knowledge of construction techniques and experiencing more complex builds.



Figure 2: Example of 360-degree image taken with a 2K LG 360 camera

### Research method

The research activity involved 14 students from a level three applied trades course and 22 students from a carpentry course, participating in two separate events. Of those participants, seven were female and 78% of participants were under 25 years of age, with the majority indicating no previous experience on a construction site. In total eight staff were involved, two of whom were advisors from the Teaching and Learning Centre. The session involved three separate assessment activities that each student participated in and provided comparative feedback based on their experience. The first activity was the traditional approach of paper-based images, the second was the use of VR headsets, and the third involved the visual support of a computer screen. The task for each approach was to firstly identify hazards and secondly to propose a management plan for implementation. At the end of the activity, each participant was asked a range of evaluative questions based on their experience of each activity.

### Findings

Both iterations of each group revealed a high percentage of students having previously experienced VR headsets. The predominant product used is a popular gaming headset, Samsung Gear VR. Furthermore, 75% of students felt VR technology was appropriate for this course. However, the number of students who expressed an interest in using this technology as a learning resource outside of class, was much less at 29%. This could indicate students are more interested in using VR as a gaming resource and shows a broader scope of work is required to explore its use within an educational environment.

Nearly all students agreed that, as an assessment, the VR activity was fair, expressing possible benefits of future uses within the course. When asked to compare which

activity was more realistic almost all students leaned towards the VR headset activity. However, there was a significant difference in the responses between the groups when prompted to compare which activity provided the most learning. 90% of the allied trades students voted for the VR headset activity but only 57% of the carpentry students agreed, and 33% were in favour of the web browser activity. The allied trades students only had access to a web browser version via a laptop and, by comparison, the other group had access to the web browser version via a large screen shared amongst a team of students. From an observation point of view, the unique difference was students from allied trades completed the activity individually whereas the carpentry students were able to complete the activity as a team. This highlighted that students value group work and this needs to be considered for future purposes. Although the VR headset activity required students to work in pairs, the task itself was completed individually with the other student simply recording data.

One student also made comment on how this technology has supported learning with dyslexia and would prompt some consideration of future benefits to those who have learning disabilities. However, careful consideration of the further use of VR headsets is also needed, with another student acknowledging that wearing the headsets had a negative effect on eyesight. Despite some mixed views from the students, the majority of participants felt they would be safer entering a workplace as a result of the VR activity.

## **Discussion**

Vocational education students are predominately hands-on learners and often learn best by experience and application. Situated learning for health and safety has previously been impossible to replicate or simulate in a safe environment, and virtual technology has afforded genuine options to bridge this gap for our students. The data also indicated that neither gender nor age appeared to be an issue, with no consequential anomalies identified.

VR technology has allowed the facilitation of the following elements mentioned by The New London Group (1996) of experience through simulation, conceptualised environment, followed by analysis and application of the given task. In what was traditionally a simple analysis task, it has now incorporated experience, conceptual, analysis and application, to encompass a far more complete experience. It is not the technology itself that offers quality learning, rather it is the manner in which it presents strategies for the learner to develop (Kahn 1997). In this respect, we are offering a package that allows facilitation for learning and empowering learners to construct their own ways of knowing.

## **Future Research**

Future consideration of the need to upskill staff and the impact on budgets is required to ensure this is a sustainable practice. Furthermore, there is a need to ensure the range of construction site videos and photos are continuously being added to. This is to ensure the Institute is staying on top of the latest trends in construction and providing our students with the most up to date experiences.

Further evaluation is proposed to take place in two stages. Firstly, students will be surveyed immediately after using the VR building app. The survey will focus on gathering student impressions of the level of immersion they felt using the VR,

whether it increased their engagement with the subject matter and whether they felt it would more adequately prepare them for their upcoming experiences on the construction site. Secondly, after students have completed their subsequent construction site experiences, a subset of them will be interviewed in order to ascertain if their expectations post using the VR building app were realised on the construction site. The findings of this study are expected to be generalisable to a number of other discipline areas, in particular those where it is commonplace for students to participate in work placement type learning experiences.

Initial work on this project with VR in construction will largely focus on the use of teacher generated content and individual experiences. However much of the literature indicates that student learning outcomes are much improved when they are actively involved in the creation of knowledge and able to collaborate and interact with their peers. Future work is planned to explore opportunities for student-created VR content to be shared with other students and become a significant part of the learning process. As the technology matures it is also expected that students will be able to interact more easily within a VR environment, providing a further level of authenticity to the simulation.

## Conclusion

In conclusion, although VR technologies cannot replace 'real world' experiences, they provide increased opportunities for situated learning (Brown et al., 1989). As supported by Voogt & Knezek (2008), effective learning environments can only take place when technology is coupled with good learning design through effective integration, at which point the true benefits of technology can be realised. With the vast number of technologies available, it can be difficult to determine what is relevant, engaging and useful to learners, and this experience has proven to be positive for learners.

Finally, this study has shown that students valued the use of virtual technologies and enjoyed participating in a new concept that allows them to engage in a simulated learning environment. The results from this initial research will help further develop the investigation of virtual technologies in vocational education and may potentially assist in future collaboration with other areas of applied practice.

## References

- Boulos, M. N. K., Hetherington, L., & Wheeler, S. (2007). Second Life: An overview of the potential of 3-D virtual worlds in medical and health education. *Health Information and Libraries Journal*, 24(4), 233–245. <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1471-1842.2007.00733.x>
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.
- Collins, A. (1991). Cognitive apprenticeship and instructional technology. In L. Idol & B. F. Jones (Eds.), *Educational values and cognitive instruction: Implications for reform* (pp. 121–138). Hillsdale, NJ: Lawrence Erlbaum Associates.
- De Freitas, S., & Neumann, T. (2009). The use of exploratory learning for supporting immersive learning in virtual environments. *Computers & Education*, 52(2), 343–352. <https://doi.org/10.1016/j.compedu.2008.09.010>

- Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology*, 36(3), 439–451. DOI: [10.1111/j.1467-8535.2005.00477.x](https://doi.org/10.1111/j.1467-8535.2005.00477.x)
- Fowler, C. (2015). Virtual reality and learning: Where is the pedagogy? *British Journal of Educational Technology*, 46(2), 412–422.
- Galarneau, L. L. (2005). *Authentic learning experiences through play: Games, simulations and the construction of knowledge*. Digital Games Research Conference 2005, Changing Views: Worlds in Play, June 16–20, 2005, Vancouver, British Columbia, Canada..
- Herrington, J., Oliver, R., & Herrington, A. (2007). *Authentic learning on the web: Guidelines for course design*. Hershey, PA: Information Science Publishing.
- Herrington, J., Reeves, T., & Oliver, R. (2010). *A Guide to Authentic E-Learning*. New York: Routledge.
- Huang, H-M., Rauch, U., & Liaw, S-S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers and Education*, 55(3), 1171–1182. <https://doi.org/10.1016/j.compedu.2010.05.014>
- Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Hall, C. (2016). *NMC Horizon Report: 2016 Higher Education Edition*. Austin, Texas: The New Media Connection. <https://www.sconul.ac.uk/sites/default/files/documents/2016-nmc-horizon-report-he-EN-1.pdf>
- Kahn, B.H. (Ed.). (1997). *Web-based Instruction*.. Englewood Cliffs, NJ: Educational Technology Publications.
- Shehri, W. Al. (2012). Work integrated learning (WIL) in virtual reality (VR). *International Journal of Computer Science Issues*, 9(5-2), 332–344.
- Smith, P. E. (1987). Simulating the Classroom with Media and Computers: Past Efforts, Future Possibilities. *Simulation & Gaming*, 18(3), 395–413.
- The New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60–93. Retrieved from <https://doi.org/10.17763/haer.66.1.17370n67v22j160u>
- Voogt, J., & Knezek, J. (Eds.) (2008). *International Handbook of Information Technology in Primary and Secondary Education*. New York, NY: Springer-Verlag New York Inc.
- WorkSafe New Zealand. (2018). *Workplace fatalities by focus area*. Wellington, New Zealand: WorkSafe New Zealand. Retrieved from: <https://worksafe.govt.nz/data-and-research/ws-data/fatalities/by-focus-area/>



## Virtual welders and their effectiveness in developing welding skills: Student perspectives



Lee Baglow and Chris Lovegrove

### Abstract

Welding is an essential skill which spans across a range of trade occupations. However, welding has always been a difficult skillset to acquire due to the need to bring together a multiplicity of complex motor skills and to apply a high level of cognitive understanding towards effectively accomplishing the process. In this paper, we rationalise, describe and report on a project to introduce and refine the use of VR welding simulators. The project sought to assist novice welders' initial introduction to the welding process. The data was then synthesised to detail limitations and implications for the deployment of VR welding simulators.

### Introduction

Welding is one of the most challenging trade skills to learn and is difficult to master. It requires the acquisition and eventual embodiment of a complex range and number of motor skills to be performed, often under tight time constraints and in constricted (e.g. under or between machinery) or airy (e.g. high-rise construction) spaces. Additionally, welding is performed whilst encumbered by personal protective equipment (PPE). PPE for welding includes thick welding gloves, overalls, aprons and welding helmets. These PPE limit the welders' physical movement and make the sociomaterial aspects of welding less accessible. Sociomaterial contributions to learning welding encompass a range of multimodal (aural, visual, tactile, body positioning), tool and machinery handling and environmental (heat, noise, light, spatial awareness) conditions. The welder is also required to draw on a deep understanding of how the welding process is undertaken and the relationships between the various settings on welding machines and their impact on welds.

In a previous article (Chan & Leijten, 2012), the use of peer feedback was proposed to assist novice welders. In this article, the use of a VR welding simulator is used to accelerate novice welder's initial interaction with the welding process. The promise of VR, especially for assisting skills learning, is only now being realised (Da Dalto et al., 2010). VR is different from virtual environments and simulations as VR immerses learners into 3D spatial environments. Learners perceive themselves as being within the VR environment and can interact with physical artefacts. However, Fowler (2015) advocates that there is a need to ensure the pedagogical implications are at the forefront when adopting VR assisted learning. The use of the machines to promote learning has often been based on assumptions and informal observations of the superiority of technology-enhanced learning. Therefore, there was a need to determine how to better utilise virtual welding in a high-technology learning environment.

## **Background and rationale for introduction of VR welding simulators**

Welding is a skill whereby mastery is reliant on practise. Welding requires the learner to continually self-assess their welding performance. Therefore, it is essential when building learner welding proficiency, to ensure foundational learning includes opportunities to gain familiarity with the machinery and parameters of the weld. For the welding tutor, teaching welding technology practical skills is challenging. This is due to the environment in which welders apply their trade. The severely restricted levels of visibility and intense heat created by the welding process, combine to restrict tutor guidance. It is assumed that VR can alleviate some of these issues, especially at the early stages of welding skill development, with the machines' ability to provide instantaneous assessment of performance.

The ability of the machine software to offer immediate intervention, promotes student agency in the assessment and learning process. Assessment for learning, according to Heritage (2018), is integral to teaching and learning. The machine promotes self-regulated learning which conditions students to become active agents in their own learning. Further, the depth of information provided by the VR software has the potential to develop learners' ability to self-assess their welding performance. The learning and judgement is a crucial aspect of any trade skills (Chan, 2015).

When in use, the VR machine provides learners with a multitude of information. As the VR weld progresses, the simulator monitors learner's performance. Variables such as contact to work distance (CTWD), travel speed, travel angle, work angle, position and depth of weld penetration, are analysed and fed back to the learner as both a numeric score and line graphs. The software also records a visual representation and presents it. This provides the learner with a useful indication of the appearance of the weld.

The quantitative information provided, proved to be difficult for learners to comprehend. To improve this capability, the teaching staff identified that a system of scaffolding was required. As Heritage (2018) notes, scaffolding provides a mechanism which helps the learner achieve a goal that is currently beyond their unassisted efforts. To optimise learning, the VR welding simulator generates learning analytics. Learners are required to interpret and act on this data; this has proven to be an important stream of feedback, which is only useful if learners can access and act on it.

The rationale for the adoption of VR simulators include the health and safety imperative. As noted earlier, welding possesses some inherent dangers that may cause serious harm and, if used incorrectly, destruction of property. The simulators do not pose a health and safety risk. This is an important factor in allowing learners to hone their welding skills in a safe environment.

The VR welding machines have an inbuilt gamification element. When practised in groups, the calculated score creates an air of friendly rivalry as the learners try to compete. This has the effect of accelerating welding skill development; even when there is competition, the level of collaboration and feedback is remarkable. Also, learners quickly develop and use technical industry terminology.

The VR welding machine has built, within its software, cues that can be activated. These cues scaffold practical skill development; they also support learners that may initially struggle with the nuances and techniques of welding. In the welding bay, cues of this nature do not exist.

A student in the initial stages of welding practice can become quickly demotivated if they are not improving as much as their peers. The VR welding machine is not judgmental, and a learner who continuously improves their numeric score remains motivated and remains engaged in welding practice.

## Literature overview

### Learning a trade

In this article, the conceptualisations of social constructivism are applied to understanding how people learn a trade. As such, learning a trade requires effortful and mindful learning from the individual (the intra-psychological). In turn, individual thinking is supported by inter-psychological processes which include contributions through the support of others (e.g. peers, teachers, experts, etc.) and cognisance of the sociomaterial (i.e. awareness and communication with the environments, tools, materials, both animate and inanimate)(Chan, 2013). Thus, learning a trade includes learning how to become a trades person, and learning how to do, think, feel and be a trades person (Chan, 2013). The learning mechanisms for much of trades learning is memetic learning. Learning a trade occurs through observation, imitation and practise (Billett, 2014).

The terms grounded cognition (Barsalou, 2008) and embodied cognition (Marchand, 2010) are used in educational psychology to describe how people learn through the interactions between mind and body. Of relevance to learning how to weld, is the role of haptics. Haptics includes learning through non-verbal communications, such as touch, and incorporating ways of thinking and feeling in doing. The learning of complex manual skills is also influenced by manual actions, summarised in the term “the epistemology of the hand” (Brinkmann & Tanggaard, 2010), and the role of embodied knowledge through language use and learning via the meaning of body (Johnson, 2007). Both the brain and hand work synchronously together with no separation of one from the other (Crawford, 2009; Rose, 2005).

An example from a recent project working with welding tutors to improve teaching practice (Chan & Leijten, 2012) indicated that being attuned to the sound of welding is an important welders’ skill. However, tutors assumed that the students would also be attuned to the sound of welding, as a defining factor for correct welding processes. Therefore, the skill to listen to the sound of welding had become embodied into the practice of expert welders. The ability to gauge welding efficacy through sound, is therefore a specialised and assumed expert welder skill.

### Skill attainment of welding

A competent welder will exercise their skill through a series of controlled motions with intense levels of concentration. As Da Dalto et al. (2010) elaborate, a skilled welder will consistently consider many variables, including the behaviour of the weld pool, the penetration of the weld while interoperating sensory feedback from the welding gun and the sound generated by the welding process. The requirement to be able to interpret the large volume and variety of information, represents a significant initial challenge to the learner.

Learners are also confronted by the inherently hazardous nature of welding. This requires significant PPE, which includes the mandatory use of thick and cumbersome gloves, which dramatically limit feel. Further, the intensity of the arc generates blinding light and molten metal sparks. Therefore, electric welding demands the use of

a face shield with protective lenses. The disorientation faced by learners when they don the welding mask can be extremely challenging and, for many learners, bewildering. Some of these barriers and challenges may be offset or eliminated by the introduction of VR welding technology ( Stone et al., 2013).

### The use of VR in Technical Vocational Education and Training (TVET)

In considering VR for TVET, it would be prudent to offer a definition. According to the Virtual Reality Society (2017), the term VR, in its simplest form, means near reality. In a technical context, VR is a term used to describe a three-dimensional, computer-generated world (Borsci et al., 2014). Carr (1995) acknowledges that despite the multifarious definitions for VR, there is a consensus that:

*“Virtual reality is concerned with the stimulation of human perceptual experience to create an impression of something which is not really there.”*

VR in TVET, is used as a mechanism to assist learner’s application of knowledge in its procedural form (i.e. praxis). When used in teaching, VR has the potential to be extremely beneficial in strengthening learners’ skill acquisition (Da Dalto et al., 2010). This is an advantage which according to Borsci et al. (2014), accelerates the learner’s ability to perform the procedures of their chosen discipline correctly and proficiently. However, despite research detailing and confirming the effectiveness of VR in the fields of surgery, military and aviation, there is little research into the effectiveness of VR for learning and assessment in TVET (Borsci et al., 2014).

VR does offer trainers the tantalising opportunity for long-term savings. For example, due to the cost of material and the significant use of consumables, welding training is inherently expensive. Further, investment in VR equipment for welding has the potential to decrease waste, consequently minimising potential damage to the environment (Da Dalto, et al., 2010).

### Role of VR welding simulators on assessment for learning

With such a scarce library of effective research relating to the use of VR in TVET, it is appropriate to question the value of VR in relation to learning and assessment. According to Airasian (1994), the purpose of assessment is to promote learning and measure achievement. Assessment should not be used in isolation; it also has the potential to be a tool that helps determine the effectiveness of a programme of study. However, in the context of the work reported in this article, assessment is utilised as a tool to measure the effectiveness of the VR machine. It is argued by Borsci et al. (2016), that traditionally, TVET (which includes industry training) utilises learning by observation and learning by doing as the mainstay of building competency.

### Research method

The researchers used a qualitative approach to generate data from the two groups of students studying for the Certificate in Automotive and Mechanical Engineering. The conclusions and recommendations were drawn from the data collected, and the analysis came from two data gathering methods: semi-structured interviews and focus group interviews.

The research questions were:

1. Do learners consider Virtual Welding technology beneficial to the development of practical welding skills?
2. Does the ability to receive peer feedback during VR practice sessions contribute to building a deeper understanding of the more technical aspects of welding technology?

## Findings

The first cycle of this research identified that learners valued the affordances provided by virtual welding technology. Collectively, learners found using the VR simulators to be extremely useful at the beginning of their welding experiences. However, as novice welders gained confidence and improved levels of skills, they felt more comfortable using the real welding machine. It also became apparent that the teaching team were not using the VR machines to their full potential, severely restricting the potential of VR to promote independent learning.

### Novice learners' experiences with VR welding simulators

The study established that there were tangible benefits with using VR to develop welding skills. In the first stages of VR machine use, learners were introduced to the physical 'set up' of the machine, as would be required with a real MIG welder. If settings are entered incorrectly, the VR machine will not begin the welding process. As with the real metal inert gas (MIG) welder, the VR machine requires the correct input of voltage, amps and gas flow. These variables are set to the thickness of the material and type of weld to be practised. At the initial stages of the training, where students practised on both VR and MIG machines simultaneously, learners noted that the VR machine provided them with a solid understanding of the relationship between machine settings and the material. The machine software achieves this by requiring the correct set up of welding parameters against the thickness of the material and, also, the welding position. If the student inputs the wrong settings, the software stops further progression until the issue has been rectified.

Further, the study established that the VR machine had developed learners' physical stance and positioning. This aspect of motor skill learning contributed to the development of muscle memory (Stone et al., 2013). The VR also introduced the fundamentals of travel and angular positioning of the welding torch. These newly developed skills proved transferable when learners encountered the real MIG machines for the first time. Researcher observations noted that the learners employed the same stance and gun angles as developed during the VR sessions. It was also observed that the VR machines made a significantly positive impact in preparing learners for MIG welding. An additional advantage of VR was its accessibility, and not having to wear cumbersome PPE during the VR sessions was a highlight that allowed learners to practise and develop in relative comfort.

### Enhancing peer learning

From the study, it was noted that the VR machines inherently possess a social learning factor. Because the VR machines are not limited by the natural dangers of the MIG welding process or the inhibitive restrictions of the mandatory PPE, learners had

the opportunity to observe and learn from one another's technique. This proved to be extremely powerful over the course of the VR sessions, and it was noted how conversations became more complex as the sessions continued. When explaining the process used, learners used appropriate technical language and became confident in articulating their experiences through technical terminology. Further, peer assessment of each other's VR welding performance began to occur naturally. Peer feedback was given in the spirit of friendship and competition.

#### Additional feedback through learning analytics

After completion of a VR weld, the machine presented learners with a great deal of information regarding their welding performance. The feedback information from the VR simulator is presented as three indicators of performance: a line graph, graphic image of the weld and a numeric score.

The feedback is not presented as the answer, but rather presents a non-threatening display of weld performance, highlighting areas for improvement. This contributes to providing the best opportunities for learning and the development of self-assessment skills. As Hattie and Timperley (2007) explain, if feedback is directed at the right level, it assists learner comprehension and promotes engagement, while developing effective strategies to process and apply the information to be learned. The graph provides a visual representation of the angle and position of the welding torch. The score is a simplistic mechanism for representing welding performance, while the image provides a digital representation of the actual weld. The benefit of having a complex variety of feedback is that its meaning becomes more relevant as learning progresses.

Initially the learners focused on the numeric score. Many viewed this as something akin to a video game, which therefore promoted a level of competition in the quest to achieve the highest score. Inadvertently, the competition improved welding technique as the highest score was consistently raised. As the course progressed, and the learners gained experience, the graphs displayed on the VR became a source of curiosity. This in turn, offered the opportunity for learner-led technical conversation aimed at improving not only practical performance but technical knowledge as well.

#### Sociomaterial factors

The research identified several sociomaterial factors. The VR masks, which are welding masks adapted to support the VR headset, was a strength. The mask was comfortable and the display clear. This provided the learner with good visibility of the VR weld. The design of the VR mask simulates a self-darkening auto shade welding mask. However, when undertaking real welding, the welding bays were equipped with fixed shade masks, which made positioning and starting the weld difficult. There were comments relating to the significant difference between fixed and auto shade masks. There was also significant dissatisfaction with having to use fixed shade masks.

The weight and feel of the welding gun also came in for criticism. This only surfaced after the learners had had several sessions in the MIG welding bays. When returning to VR for 'fine tuning skills', learners found the weight and feel of the VR gun significantly different from the MIG gun. The research identified that as the course progressed, the physical and sensory differences between VR and MIG welding became more apparent. As mentioned, the physical feel of the gun, spooling of the wire, wire stick

out, heat and sound of the weld were highlighted as areas for improvement. There were also several learners who felt VR had not prepared them sufficiently and that the VR sessions betrayed the true nature of MIG welding.

There was a concern that VR was more difficult because of the challenge involved in judging the effective distance between the work piece and the VR gun. Then again, the VR machine does possess the ability within its software to activate guides to correct operator gun position.

### Tutor capability

The way in which the tutors used the VR machinery was also cause for criticism. The VR machines were set up with only one type of weld. The rationale being that the weld was representative of the assessment test pieces. As welding progressed and learners became more proficient, returning to the same VR weld constantly proved to be a limiting factor for the promotion of continuous VR learning. Many learners wished to expand their welding skills by practising other more complex welds. Learners felt that not being allowed to do this was an opportunity missed.

The study identified that the overall value of VR was extremely high. However, the environment where the machines were located was unattractive. There was also significant criticism directed toward the limited free access to the VR machines. Many learners spoke of how they would have liked more opportunity to practise during their free time.

## Discussion

The study identified that learners would not be prepared to learn and practise their welding skills solely in VR. Nevertheless, a consistent theme of the feedback was an appreciation of the value of VR in helping to develop, at the very least, a basic welding technique.

As a part of the study, it was important to recognise the impact of VR on real welding, in terms of welding practice, underpinning knowledge and learner self-assessment. Learners were asked to present their work and discuss key elements of their test pieces. The study identified that learners could indeed self-assess their work accurately and offer a critique of performance. Further, learners could offer a synopsis of required corrective actions. The self-assessment sessions were videoed by the researcher and playback and analysis identified that the language used was contextually correct. This provided evidence that time spent with the VR welder was developing learners in the appropriate skills for the trade.

## Implications and recommendations

The findings identified that learners valued VR for the development of welding skills. However, learners offered several different perspectives as to the value of VR technology once they believed that they had become proficient with the physical welder. Nevertheless, there were a number of learners who expressed a significant value in returning to the VR machines to 'fine tune their skills'. Once the VR weld had been completed, the machines software generated a score, which the learners considered to be a motivating factor.

Open access to the VR machines was viewed as a critical factor for their continued use. Learners expressed a level of frustration when they were not able to use the machines during their free time. A positive feature of the VR machines was the ability for learners to offer and take advice and guidance from their peers. Further, there was consistent acknowledgement and agreement that the VR machines had developed muscle memory and went some way to developing the technical aspects of welding.

The study identified that the VR machines were not being used to their full potential. The insistence of the teaching team that practising the weld in VR, to improve the quality of the assessment test piece, proved to be a limiting factor which curtailed learner motivation for VR use, especially in the later stages of the course.

## References

- Airasian, P. W. (1994). *Classroom assessment*. New York: McGraw Hill.
- Barsalou, L. W. (2008). Grounded Cognition. *Annual Review of Psychology*, 59, 617-645.
- Billett, S. (2014). *Mimetic learning at work: Learning in the circumstances of practice*. Dordrecht, Netherlands: Springer.
- Borsci, S., Lawson, G., Salanitri, D., & Jha, B. (2016). When simulated environments make the difference: the effectiveness of different types of training of car service procedures. *Virtual Reality*, 20(2), 83-99. DOI: [10.1007/s10055-016-0286-8](https://doi.org/10.1007/s10055-016-0286-8)
- Brinkmann, S., & Tanggaard, L. (2010). Toward an epistemology of the hand. *Studies in Philosophy and Education*, 29(3), 243-257.
- Carr, K. (1995). Virtual Reality: Tool or Concept. In K. Carr & R. England (Eds.), *Simulated and Virtual Realities: Elements of Perception*. Bristol: Taylor & Francis.
- Chan, S. (2013). *Learning a trade: Becoming a tradesperson through apprenticeships*. Wellington, NZ: Ako Aotearoa Southern Hub. Retrieved from <https://ako.ac.nz/assets/Knowledge-centre/RHPF-s1301-Learning-a-trade/e9f27e46b3/RESEARCH-REPORT-Learning-a-Trade-Becoming-a-Trades-Person-through-Apprenticeship.pdf>
- Chan, S. (2015). Apprentices' learning of occupationally informed practical judgement. *Vocations and Learning: Studies in vocational and professional education*, 8(3), 335-351. <http://link.springer.com/article/10.1007/s12186-015-9134-3>
- Chan, S., & Leijten, F. (2012). Using feedback strategies to improve peer-learning in welding. *International Journal of Training Research*, 10(1), 23-29. <http://www.tandfonline.com/doi/abs/10.5172/ijtr.2012.10.1.23#.VaQ6sKON3Gg>
- Crawford, M. B. (2009). *Shop class as soulcraft: An inquiry into the value of work*. New York, NY: Penguin.
- Da Dalto, L., Balet, O., & Benus, F. (2010). *The use and benefits of Virtual Reality tools for welding training*. Paper presented at the 63rd Annual Assembly & International Conference of the International Institute of Welding, Istanbul, Turkey.
- Fowler, C. (2015). Virtual reality and learning: Where is the pedagogy. *British Journal of Educational Technology*, 46(2), 412-422.
- Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Education Research*, 77(81).



- Heritage, M. (2018). Assessment for learning as support for student self-regulation. *The Australian Educational Researcher*, 45(1), 51-63.
- Johnson, M. (2007). *The meaning of the body: Aesthetics of human understanding*. Chicago, IL, US: University of Chicago Press.
- Marchand, T. H. J. (2010). Embodied cognition and communication: Studies with British fine woodworkers. In T. H. J. Marchand (Ed.), *Making knowledge: Explorations of the indissoluble relation between mind, body and environment*. Malden, MA: Wiley-Blackwell.
- Rose, M. (2005). *The mind at work: Valuing the intelligence of the American worker*. New York, NY: Penguin.
- Stone, T., McLaurin, E., Zhong, P., & Watts, K. (2013). Full Virtual Reality vs Integrated Virtual Reality Training in Welding. *Industrial and Manufacturing Systems Engineering*, 92(6), pp167-174..
- Virtual Reality Society. (2017). *What is Virtual Reality?* Retrieved from <https://www.vrs.org.uk/virtual-reality/what-is-virtual-reality.html>