LONDON METROPOLITAN UNIVERSITY

An Optimised Competency Framework for Improving Students' Self Skills during Work-Related Learning

A thesis submitted to London Metropolitan University for the degree of Doctor of Philosophy in Computing

Preeti Patel

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Abstract

This research commences with an exploration of the huge landscape of assessment feedback practices in which a multitude of tools, interventions, theories, experiences, experiments and surveys have been proffered by educationalists and practitioners. A novel taxonomy of feedback is developed which, upon evaluation, not only highlights the gap in feedback provision for the experiential learning area but also reveals the significance of developmental feed-forward guidance with which students are able to self-evaluate and self-regulate themselves.

The research goes on to investigate the impact that Work-related learning and developmental feedback can have on students on a degree programme. An intervention consisting of a range of tools, including a customised competency framework, developmental feedback cues and self-evaluation scoring, is developed to engage and motivate students on the Work-related learning module.

A study conducted to test the intervention reveals that significant improvements can be seen in students' understanding and perception of their competencies, but that this improvement is only apparent when both Work-related learning and developmental feedback based on self-evaluation are implemented. The findings from the empirical data derived from the study has enabled the understanding of, through cluster and correlation analysis, the way in which students perceive their own competencies; thereby, leading us to optimise the framework to include the thirteen most significant competencies within the Academic, Workplace and Personal Effectiveness categories.

This research contributes towards a better understanding of student perceptions of competency and puts forward a strategy for improving the employment outcomes of graduates through exposure to a customised competency framework, developmental feedback and self-evaluative/reflective practices.

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Having spent almost three decades amongst students, I would like to acknowledge their engagement in my teaching generally and also to those students, in particular, who participated in the surveys and interviews conducted in this research.

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Table of Contents

List of Figures

List of Tables

Glossary of Abbreviations and Acronyms

ALDinHE	Association for Learning Development in Higher Education
BCS	British Computer Society, The Chartered Institute for IT
BIS	Department for Business, Innovation and Skills
BMA	British Medical Association
BME	Black and Minority Ethnic
CBA	Computer-Based Assessment
CDIO	Conceive-Design-Implement-Operate
CFWRL	Competency Framework for Work-Related Learning
DLHE	Destination of Leavers from Higher Education
ERIC	Education Resources Information Center
FEC	Further Education College
HCPC	Health and Care Professions Council
HE	Higher Education
HEA	Higher Education Academy
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
IEEE	Institute of Electrical and Electronics Engineers
IET	Institute of Engineering and Technology
IISP	Institute of Information Security Professionals
MCQ	Multiple Choice Question
NICE	National Initiative for Cybersecurity Education
NNS	National Student Survey
NUS	National Union of Students
PBL	Project-Based Learning
PCA	Principal Component Analysis
PLE	Project-Led Education
SFIA	Skills Framework for the Information Age
SPSS	Statistical Package for Social Science
WRL	Work-Related Learning

Conference publications

D Palmer-Brown, FF Cai, P Patel (2017), "An Optimised Competency Framework to Prepare Students for Employment", 11th International Technology, Education and Development Conference, INTED2017 Proceedings, Spain, pp. 5399-5410, doi: 10.21125/inted.2017.1260

D Palmer-Brown, FF Cai, P Patel (2016), "Classifying and Evaluating Assessment Feedback Practices", 9th International Conference of Education, Research and Innovation, ICERI2016 Proceedings, pp. 6495-6506, doi: 10.21125/iceri.2016.0483

D Palmer-Brown, FF Cai, P Patel, (2016), "Competency-based Feedback for the Improvement of Employment Outcomes for Computing Students", International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, pp. 252-257., doi: 10.1109/CSCI.2016.0056

D Palmer-Brown, FF Cai, P Patel, (2015), "Learning from Feedback on Work-Related Learning: Skills Acquisition and Reality Check", Conference on Higher Education Advances HEAd'15, Valencia University, Spain, doi: 10.4995/HEAd15.2015.330

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1. Introduction

This thesis reports on research work undertaken to enhance the experiences of undergraduate students in order to better prepare them for employment. The research encompasses two main threads of investigation, both of which attempt to understand and respond to student perceptions and student outcomes. Firstly, is that despite a huge plethora of assessment feedback practices, students are, surprisingly, even now often unable to utilise the feedback given to them. Secondly, is the economic and social factors forcibly driving the Higher Education (HE) landscape to evolve to become a preparatory environment for graduate employment. Hence there is marked and significant move towards embedding employability initiatives within academic programmes, with HEIs creating organisational structures which encompass and coordinate the employment outcomes of their student population. The Higher Education Academy (HEA) also focus on this aspect, particularly for students on Computing-related degrees with the running of dedicated workshops and training to better understand and disseminate the good practices related to improving the employability of those students. Given an increasingly competitive education sector and employment markets, the value of the skills developed while at University often forms an important part of students' choices in education.

1.1 Context

We begin to contextualise the work by setting out the importance of evaluating current feedback practices. Despite a vast body of research in this area, a gap in the feedback mechanisms for Work-related learning experiences is identified. Also identified is the significance of developmental feedback and self-regulatory practices that could support Work-related learning experiences. The section goes on to describe briefly the investigations and developments of this research which have been undertaken to consider competency frameworks in a way which has not been done previously via statistical analysis. The section also highlights the importance

of personal development which has been found to be not as prominent in students' competency building as it beneficially could be.

1.1.1 Current Feedback Practices

The provision of feedback is an area which has received much interest in modern education, particularly in Western countries. Approaches to providing such feedback are myriad and include technology-assisted approaches, amongst others, such as adaptive eLearning environments, neural computing, web-based environments, video technology, formative audio feedback, screencasts and augmented reality.

Given that the approaches to providing feedback are myriad, it is desirable to advance a systematic method of understanding the most constructive feedback types. Therefore, the development of a taxonomical classification is undertaken which provides structure, order and frame to current popular practices that have evolved during the last decade. The taxonomy is then evaluated with the use of multiple dimensions such as effectiveness/impact, satisfaction, adoption/engagement and quantity of feedback. The taxonomy evaluation reveals a two-fold gap: firstly, the importance of developmental feed-forward guidance with which students are able to self-regulate and evaluate themselves; secondly, the 'not-fit-for-purpose' aspect of feedback provision for Work-related learning initiatives.

1.1.2 Professional Competency Frameworks for Academic Programmes

A scoping study performed early on in this research reveals the need for a deeper investigation to consider the manner in which students can be better supported in the practice of competency-building, with a more impactful feedback format, during Work-related learning. We have identified a gap in the type of feedback format on employability-related skill development to prepare students for the world of work.

Professional competency frameworks, whilst playing a major role in the workplace, are deemed unsuitable for use within an academic programme as they tend to be lengthy, too fine-grained and often tied to a particular profession. Hence, there is a

need to devise a customised competency framework consisting of the most significant competencies that students could usefully improve upon. In this research, we conjecture that a framework in which competencies are tightly bound and minimal, yet with no loss of explanatory power, is of most benefit within an academic programme. To this end, we have made use of statistical methods, particularly cluster and correlation analysis, in a novel way to arrive at an optimised competency framework.

1.1.3 The Importance of Personal Development

In this research, we give prominence to those skills which promote personal effectiveness in the workplace and beyond by coining the term 'self-skills'. The word 'self' can precede a wide variety of verbs and nouns. However, our focus is on the concepts which relate to students' enhancement of workplace skills such as self-development, self-management, self-motivation, self-awareness, self-presentation, self-evaluation, self-reflection and self-regulation.

Assessment practices and instruments have evolved to encompass the practice and development of self-assessment and self-appraisal within taught modules, however, it is during a Work-related learning experience that students can receive exposure to a wider ranging appreciation of self-skills by contextualising them to workplace tasks. Opportunities to provide relevant feedback at multiple stages of a Work-related learning experience can help to rejuvenate students' motivation and effort, thereby enabling the practice of self-skills.

1.2 Motivation and Justification

The primary motivation for this work stems from an interest in factors related to students and their ability to become more employable. These factors include: the relative perceived value of a degree, students' ownership of their own learning and development, assessment and feedback mechanisms, competency-based education and work-related learning. This broad interest has led to an early insight into areas which appear to have gaps that need further investigation:

- Current feedback practices for work-related learning
- Students' ability to competency-build effectively during their studies
- An environment to practice self-development.

The research work addresses these gaps with the development of an optimised competency framework and developmental feedback for work-related learning.

1.3 Research Questions and Hypothesis

The overall hypothesis is that students' ability to competency-build and self-develop can be improved with the use of a practical intervention utilised during work-related learning. Important questions arising from this initial hypothesis lean towards the improvement aspect and include:

> What mechanisms are currently available for feedback?
>
> How can students practice building competencies and what shape would those competencies take?
>
> How can students be exposed to the self-skills development aspects of academia?
>
> What part does work-related learning play in employability and how can this be optimised?

These questions have been addressed with the design and implementation of a taxonomy of feedback (Chapter 3), an adapted competency framework (Chapter 5 and 8) and developmental feedback (Chapter 6). We propose a practical strategy which powerfully combines these tools for improving the employment outcomes of students.

1.4 Research Aims and Objectives

The overall aim of this research is to critically evaluate current feedback practices and professional competency frameworks in specific ways and investigate their adapted use for Work-related learning by considering the optimal ways in which the employment outcomes of students on an academic programme can be enhanced. One initial and important aspect to consider is the particular type of developmental strategy and opportunities for tutor and self-feedback that can be specifically

designed for students undertaking a Work-related learning module. Therefore, the main research objectives are:

- To extensively and critically review current feedback practices, particularly within HE.
- To present a new contribution to knowledge through the development and evaluation of a taxonomy of feedback practices in order to identify predominant, underutilised and hybrid forms.
- To explore professional competency frameworks and assess their suitability for use on an academic programme.
- To present a new contribution to knowledge through the development, implementation and evaluation of a set of intervention tools, including a customised competency framework, developmental feedback cues and self-evaluation methods, to inform a strategy for the improvement of student employment outcomes.
- To apply a range of statistical and modelling techniques, including general linear modelling, cluster analysis, principle component analysis and correlation analysis to interpret the data findings, and more importantly for optimisation purposes.
- To propose a practical strategy which powerfully combines a range of tools for improving the employment outcomes of students.

1.5 Overview of Research Methodology

A mixed methodology involving both quantitative and qualitative investigation was deemed appropriate for this research in order to encompass complementarity and triangulation. The survey research method (based on purposive sampling) was deemed to be the most effective way of eliciting student experiences, behaviours and perspectives. Semi-structured interviews and focus group discussions were effective in the gathering of qualitative information.

In this work, the research method is presented in two parts: an initial scoping study consisting of 41 graduate participants (Chapter 4) and the larger main study

consisting of 132 current students (Chapter 7). The data results garnered from each study have been analysed and conclusions gleaned are reported in each of the respective relevant chapters.

The aim of the scoping study in Chapter 4 is to elicit opinion and commentary on the extent to which assessment criteria and the feedback received map onto the graduate's ability to perform work tasks. The scoping study has revealed that Work-related learning when embedded into the academic curriculum does play an important role in allowing students an environment in which to acquire, practice and improve their employability skills. However, it appears that new graduates remain inexperienced and under-exposed to dealing with feedback given during the Work-related learning module in order to actually transfer their transferable skills to the workplace.

The aim of the main study in Chapter 7 is to deploy the proposed tools, namely the competency framework, developmental feedback cues and self-skills rating, in order to measure their effectiveness in the improvement of work-related learning. The analysis of the empirical data resulting from this study forms an important aspect of this work and allows for the optimisation of the competency framework through cluster and correlation techniques.

1.6 Development of Proposed Tools

As the main objective of this research is to propose a practical strategy for the improvement of employment outcomes of students, a set of tools have been designed, developed, analysed and evaluated. The tools consist of a taxonomy of feedback, an adapted competency framework, developmental feedback cues and self-skills rating. Figure 1.1 summarises these tools and gives an indication of where they are presented in the thesis.

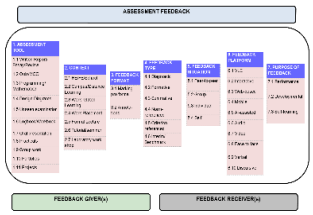
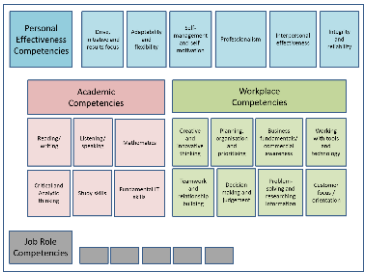
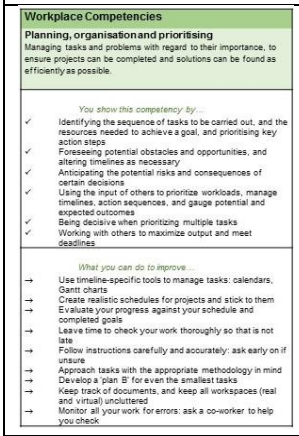
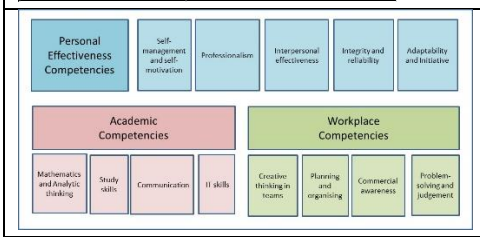
	**Taxonomical Classification of Feedback** Chapter 3, Page 43, Figure 3.3
	**Competency Framework for Work-related Learning** Chapter 5, Page 83, Figure 5.3
	**Developmental Feedback Cues** Summary of all competencies Chapter 6, Page 93, Figure 6.1 Individual competencies Chapter 6, Pages 94-113, Figures 6.2-6.21
	**Student Competency Self-rating Form** Chapter 6, Page 117 Figure 6.5
	**Optimsed Competency Framework for Work-related Learning** Chapter 8, Page 182 Figure 8.7

Figure 1.1 Summary of Proposed Tools

1.7 Summary of Contribution and Impact

This research specifically extends existing knowledge in four main ways by:

1) Identifying an underutilised area of feedback practice through the development and evaluation of a new taxonomy of feedback.
2) Identifying the most effective forms of feedback and demonstrating the power of combining feedback practices to enhance student experience and performance.
3) Arriving at an optimised competency framework with the use of numerous statistical and modelling techniques.
4) Developing a strategy to enable students to refine and improve their understanding of competency building.

This research impacts:

- **Curriculum design** with the confirmation that embedded and compulsory Work-related learning initiatives can yield benefits,
- **Students** by exposing them to much needed self -regulating and self-reflecting opportunities focussed on improvements in competencies required in the workplace,
- **New graduates** by exposing them to the practicing and evidencing of competencies in preparation for, and for use in, the workplace.
- **Academic tutors** by furnishing them with a set of tools to conduct developmental feedback sessions,
- **Employers** by helping them to differentiate amongst the high volume of new graduates entering the employment market.
- **HEI policy makers** that are mindful of the need to improve employability outcomes and thereby gain better results in the National schemes that measure institutions on their ability to produce graduates who can gain relevant graduate-level employment.

1.8 Thesis Structure

The structure of the thesis is presented in the following paragraphs, and a road map of how the chapters are connected to each other is shown in Figure 1.2.

Chapter 2 - Literature Review presents an extensive coverage of current feedback practices. As the research publications and outputs in this area are wide-ranging, a thematic approach is taken. The specific aspects of subject disciplines, use of technology, assessment types, methods and tools, the written context, peer and self-assessment, the student audience and educator preferences are all considered in this thematic approach. The review reveals a gap and highlights the need for further investigation of developmental and feed-forward strategies, with self-evaluation also been seen as an important element for the uptake and effectiveness of feedback.

Chapter 3 - Development of a Taxonomical Classification of Assessment Feedback proposes the definition and development of a taxonomy of feedback which will allow the investigation of combinations of feedback practices. The rationale for developing a taxonomy of feedback is to provide a systematic reference of the various types of feedback with associated criteria. The aim is for the taxonomy to aid in the highlighting of under-utilised or overlooked feedback types with a view to discerning any hybrid formats that may potentially work well.

Chapter 4 - Feedback Scoping Study within a Work-related Learning Context addresses an area that appears to have had very brief coverage of the feedback opportunities used to effectively assist students during Work-related learning experiences. The scoping study reveals that Work-related learning when embedded into the academic curriculum does play an important role in allowing students an environment to acquire, practice and improve their employability skills.

Chapter 5 - Competency Frameworks presents the case for the design and development of a competency framework suitable for use by students on an academic programme of study. The rationale for this development, and adaptation

of professional competency frameworks, is that the language of competency is heavily utilised by employers when considering staff selection, appraisal, continued professional development, technical training and development. However, students and new graduates are not proficient in this language and therefore face challenges when entering the employment market. The chapter puts forward a customised competency framework which students can readily utilise with a Work-related learning scenario.

Chapter 6 - Developmental Feedback and Self Skills highlights the need for a different form of feedback that is required for the Work-related Learning experience within an academic programme. The taxonomy developed in Chapter 3 affirms the significance of developmental feedback and self-management as important potential players in Work-related learning initiatives. The chapter describes the design, development and use of various tools, such as developmental feedback cues, self-rating against a set of competencies appearing in the competency framework and opportunities for self-reflection and self-regulation by students.

Chapter 7 - Deployment of Proposed Tools and Statistical Analysis presents a mixed research methodology involving both quantitative and qualitative investigation conducted via a student survey of perceptions of competency-building. A comprehensive analysis, including general linear modelling, cluster analysis, principle component analysis and correlation analysis, of the resulting data is then conducted which shows that students' perceptions of their different competencies are highly correlated. The qualitative data analysis gives further insights into student behaviour.

Chapter 8 - Optimising the Competency Framework addresses a recurring factor during interactions with students in the sample concerning the difficulties they experienced when attempting to address all the 20 competencies in a relatively short span of time. Therefore, further investigation is carried out which considers how competencies are connected to each other through the use of cluster and correlation analysis. The resulting optimised competency framework consists of a minimal and distinct set of competencies.

Chapter 9 – Discussion proffers a general consideration of possible impact and interaction between this research and some broader issues. In particular, we discuss the trending changes in HEI provision such as competency-based education, developing self-skills, digital credentials, DLHE statistics and the NSS survey.

Chapter 10 – Conclusion presents the conclusions of the thesis. The original research aims and objectives are revisited, and conclusions are derived with regard to the contribution to knowledge, the limitations of the research, and finally, recommendations for further work.

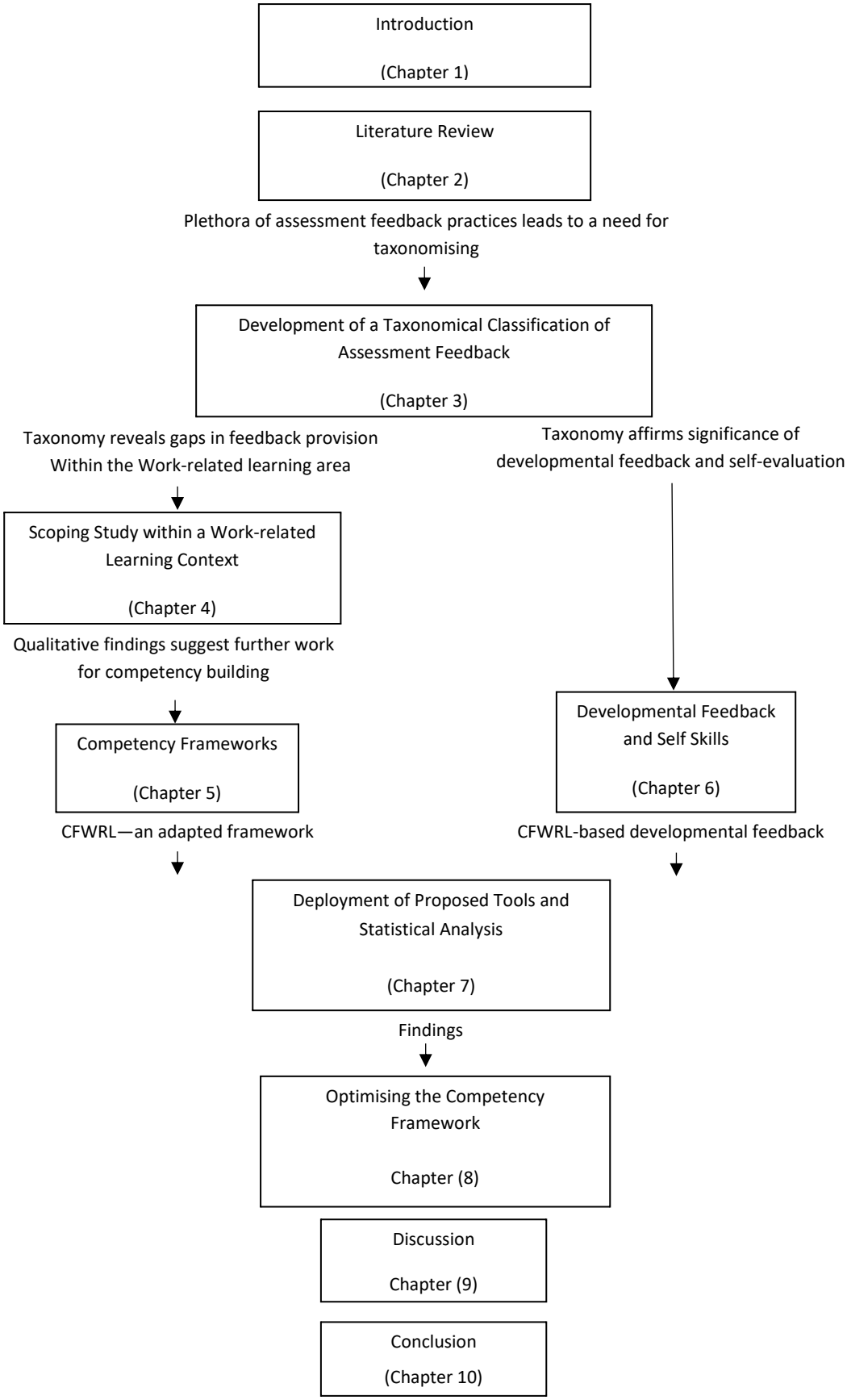


Figure 1.2 Road Map of the Thesis Structure

2. Literature Review

2.1 Introduction

This review examines research conducted on methods of assessment feedback as used mainly in the Higher Education and Schools context. The review focuses on empirical studies primarily in the area of educational practices which have been developed and utilised within the last decade. It explores the contributions of research in a variety of subject disciplines, predominantly sciences versus humanities, and in a variety of contexts such as Higher Education (HE), distance learning and teaching/learning session types.

Given that there is currently a profusion of research activity and ever-increasing output of publications describing and evaluating assessment feedback types, in this review focus is placed on themes, contexts and topics of where feedback practices can be grouped to facilitate meaningful comparison.

As a starting point, and to illustrate the volume of literature available, a generic search of the term 'assessment feedback' results in 5,639 articles from ERIC (Education Resources Information Center) of which 29% are over the last 5 years, 2,055 articles from IEEE Xplore of which 41% are over the last 5 years and 2803 articles from the Web of Science database of which 43% are over the last 5 years. A recent substantial work (Evans, 2013) represents a monumental attempt at a systematic review of the literature where initial searches found 1,131 possible articles from 5 databases, of which 460 were considered.

The sheer volume of literature demands some structure to be assigned and in this current review, a fairly broad range of research is accessed and considered here in the context of particular themes. The themes are selected so as to represent the broadest areas of discourse whilst still helping to shape the review; they include subject disciplines, assessment types, methods and tools, the written context, use of technology, educator preferences, student audience and peer and self-assessment.

Finally, the review discusses work that can be usefully conducted; highlighting the key issues to be considered and provides a starting point for further work.

2.2 Background

The provision of feedback is an area which has received much interest in modern education, particularly in Western countries. Approaches to providing such feedback are myriad and include technology-assisted approaches, amongst others, such as adaptive eLearning environments (Marcus et al., 2011), neural computing (Aleman et al., 2010), web-based environments (Miller et al., 2010) and (Wang, 2013), video technology (Crook et al., 2012), formative audio feedback (Brearley et al., 2012), synchronous video (Vakaloudis et al., 2012), screencasts (Harper et al., 2012), digital pen (Van Hell et al., 2011), augmented reality (Zarraonandia et al., 2013) and online MCQ (Marden et al., 2013).

As current pedagogic practices strongly encourage the provision of feedback and given also the current advances in digital technology, feedback mechanisms are becoming ever more sophisticated. In particular, interactive feedback styles where tutor expectations can be made explicit in a timely manner are becoming prevalent, for example (Meng et al., 2011). Other feedback styles include: multiple peer feedback (Ekoniak et al., 2013), computer-based feedback (Denton et al., 2008) and (El-Ebyary & Windeatt, 2010), formative feedback (Flusckiger et al., 2010) and narrative feedback (Stranieri & Yearwood, 2008).

Student learning behaviours have been researched for decades and much is understood about the ways in which students assimilate, digest and apply knowledge. Educational theories also provide insights into how student performance can be enhanced. However, there appears to be little understanding of how students evaluate feedback to aid their learning style and so perform better. Behavioural modelling (Maritz, 2008) in this area investigates how students can be taught to utilise feedback. Other work investigates the nature of the feedback given – with or without improvement strategies (Dujinhouwer et al., 2012). Orsmond & Merry (2011) argue that student learning aspects are not met by tutor feedback, leading to a misalignment in the provision of feedback. A study conducted by Tang & Harrison (2011) explores the importance tutors place on assessment feedback, with

results that suggest there are two broad camps: those that believe scores are enough and those that believe detailed feedback is necessary.

Crisp (2007) and Weaver (2006) question how valuable students actually find the feedback they are given. Randall & Zundel (2012) examine the use of formative feedback and what use students make of it. Rae & Cochrane (2008) investigate the perception of written assessment feedback. The investigation into students' perception of the feedback they receive has also been researched by (Pokorny & Pickford, 2010) and (Bilbro et al., 2013), although much of this work is related to feedback on compositions. Li & Barnard (2011) interestingly also look at tutor's perceptions. There appears to be a mixed perspective on what constitutes 'good' feedback and what students are actually able to do with it. (Rakoczy et al., 2013) investigate the perception of students based on their moderation of goals, whilst Marden et al. (2013) study the impact of feedback during online quizzes to the learning experience.

Feedback on student assessments is central to the effectiveness of the teaching and learning process. From the National Student Survey (NSS) summary below, it is evident that students are less happy with feedback arrangements than they are with the actual assessment. Although there appears to be a consistent improvement in satisfaction, feedback expectations are still lagging behind satisfaction in assessment arrangements. Why should that be? The plethora of research and new practices in feedback provision, whilst improving overall satisfaction, still do not appear to be having as significant an impact as envisaged. Feedback satisfaction[1] in HEIs (Table 2.1) appears to be less consistent with assessment than in FECs (Table 2.2), and there may be practices there that could be usefully investigated.

[1] Data summarised from that published annually by HEFCE. Satisfaction scores shown only for one section (of seven) of the survey. (www.hefce.ac.uk)

Table 2.1 Summary of NSS results in Taught HEI

England - Taught HEI Question	2009	2010	2011	2012	2013	2014	2015	2016
Assessment and feedback								
5 - The criteria used in marking have been clear in advance.	70	70	72	74	75	76	77	77
6 - Assessment arrangements and marking have been fair.	72	72	73	75	76	76	77	77
7 - Feedback on my work has been prompt.	57	59	62	65	68	69	70	71
8 - I have received detailed comments on my work.	62	63	66	68	70	71	72	72
9 - Feedback on my work has helped me clarify things I did not understand.	56	57	60	63	65	66	68	68

Table 2.2 Summary of NSS results in Taught FEC

*From 2015 onwards, separate FEC scores are not displayed on summary data by HEFCE

England - Taught FEC Question	2009	2010	2011	2012	2013	2014
Assessment and feedback						
5 - The criteria used in marking have been clear in advance.	75	76	77	80	80	80
6 - Assessment arrangements and marking have been fair.	78	78	78	80	81	81
7 - Feedback on my work has been prompt.	62	62	64	69	69	70
8 - I have received detailed comments on my work.	75	75	76	78	80	81
9 - Feedback on my work has helped me clarify things I did not understand.	70	70	70	73	75	77

2.3 Current Feedback Practices

A multitude of feedback practices have been developed and are currently being utilised, but with varying degrees of effectiveness. Research in this area is necessarily extremely broad and the following sections have been presented in a thematic way. The particular themes have been chosen to help shape this review as they constitute the predominant ideas appearing in current literature:

- subject disciplines,
- assessment types, methods and tools,
- the written context,
- use of technology,
- educational preferences,
- student audience and
- peer and self-assessment

It is these themes that are considered in the following sections.

2.3.1 Subject disciplines

It can be argued that a broad divide exists between the assessment type requirements within Humanities and Sciences. A plethora of research has already been (and continues to be) conducted by educators in these two areas, however, there does not appear to be much overlap here. Research and case studies in the Humanities lean towards peer, self, group and counselling types of feedback, all within the context of essays, abstracts, reflections and reports. Research in the Sciences arena leans towards the use of technology-facilitated feedback for MCQ, online quizzes, adaptive e-learning and artificial intelligence.

Language learning (particularly English) and its associated feedback provision has received much attention, with studies being developed to gauge the effectiveness of feedback for compositions, essays, portfolios and reports.

The assessment and subsequent feedback of **computer programming skills** lends itself relatively easily to the online environment. Hahn et al. (2009) extend the value of students (computer) programming in pairs and consider the necessary assessment and feedback strategies required. Closed solution **assessments in Mathematics** are another example where computer-assisted feedback methods are readily employable.

Adams & McNab (2013) suggest that feedback given to **arts and humanities** undergraduate students should focus on the understanding of standards and goals. Some interesting classroom trials are conducted by McLaren (2012) of creative

assessment in portfolio environments with design pupils and tutors. McLaren concludes that pedagogies that are supportive of and enable 'the capture of creative thinking in real time' are essential in design education.

A study carried out by Gibbs & Dunbar-Goddet (2009) across three disciplines at three different types of universities which found profound variations in: volumes of summative and formative feedback, in practices to ensure clarity of assessment goals and standards, and in the provision of written and oral feedback. Interestingly, these variations appeared to be mutually exclusive.

Offerdahl & Impey (2012) consider the use of **portfolios**, where considerable written work is to be undertaken by science students in a non-science undergraduate degree. Feedback on students' portfolio work may necessitate a different form of approach.

The above gives a flavour of why discipline-based variations necessitate different forms of feedback and it would be interesting to investigate whether feedback which is predominantly used in one area can be beneficially deployed elsewhere.

2.3.2 Assessment types, methods and tools

The type and method of assessment is fundamentally related to the type of feedback which can be/should be provided. Educators can sometimes struggle with developing an assessment that serves multiple purposes. For example, it can be difficult to formulate an assessment that not only tests for factual knowledge but also emphasises understanding, creativity, inventiveness and real-world application.

Table 2.3 gives a definitive list of assessment types[2], from which it should be possible to arrive at the corresponding mechanisms for feedback currently in use for each type.

[2] These six types of assessment are in widespread and common use, but have been reproduced directly from ww.edudemic.com

Table 2.3 Types of Assessment

Assessment Type	Description
Diagnostic	Assesses a student's strengths, weaknesses, knowledge, and skills prior to instruction.
Formative	Assesses a student's performance during instruction, and usually occurs regularly throughout the instruction process.
Summative	Measures a student's achievement at the end of instruction.
Norm-referenced	Compares a student's performance against a national or other 'norm' group.
Criterion-referenced	Measures a student's performance against a goal, specific objective or standard.
Interim/Benchmark	Evaluates student performance at periodic intervals, frequently at the end of a grading period. Can predict student performance on end-of-year summative tests.

Within the broad range of assessment methods and tools categories available (for example unseen examination, coursework/assignment, class test, oral presentation, logbook/workbook and practicals), there are several benefits of each category. Educators have experimented with various combinations of assessment methods and a normal pattern might consist of two coursework submissions and an end-of-module examination. Frost et al. (2011) describe what others have also being doing, which is to collect week-by-week tutorial work along with self-observations. However, increasing the frequency of assessment may not always be desirable or even feasible with large student classes.

The following are some examples of the types of studies and experiments that researchers have been conducting, with a view to arriving at and understanding the nature of feedback usage.

A review of the literature conducted by Gikandi et al. (2011) on the use of **online formative assessment and feedback**, reports gains to be had when utilising self-test quizzes, discussion forums and e-portfolios.

Crisp (2007) questions whether students are influenced by feedback on subsequent submissions. This study shows little variation in student performance after feedback was given between two consecutive assignments involving a similar task. Crisp asks whether "it is worth the effort?" If the only purpose of feedback was to increase student performance scores then the answer would presumably be negative.

Crisp (2012) suggests that formative and summative assessment is for current learning and that therefore other forms of assessment, which he terms integrative, should be incorporated for future learning. He advocates the use of a combination of 4 assessment methods, including diagnostic, formative, integrative and summative.

Shorter & Young (2011) make use of continuous, cumulative and **project-based assessment** in a large Mathematics course in order to determine which would be the best predictor of performance. The continuous in-class daily quizzes turned out to be the best predictor.

Hendry et al. (2011) suggest the use of **exemplars** in addition to the normal criteria-based assessment methods. They found that students welcomed the opportunity to discuss the exemplars whilst carrying out the assessment and were able to translate the ideas into their own work.

Torrance (2007) argues that over-use of formative assessment leads to coaching and practicing for assessment and does not aid deep learning. He goes on to state that assessment practices have come to dominate learning.

Cardella et al. (2011) attempt to use **multiple lenses**, taking into account student work, instructor and peer feedback, interviews and video recordings, to scrutinise the role of feedback, with an aim of ascertaining what skills instructors and students need to give and receive feedback.

Jones & Gorra (2013) concentrate on students' use of feedback provided for **summative assessment** in a Virtual Learning Environment. They conclude that although students, at the start of a module, expect that they will access feedback, by the end of the module, they are much less likely to do so.

Assessment methods are in many ways determined by the subject area. Giloi & du Toit (2013) argue that standard methods of assessment cannot be applied to the assessment of graphic design where creativity and uniqueness are to be encouraged. Lessons learnt from those assessing the creative process may be of assistance to others who seek to assess deep learning and subsequently provide sufficient feedback.

2.3.3 The written context

Much work has been done to find effective ways to provide feedback to students' submissions of written assignments. Here, we draw initially on examples from the language learning context, which can also represent other subject-based situations where a sizable written submission is to be assessed. In addition, **reflective writing** has over the past decade become a significant requirement of students – the feedback given here could benefit from good practice elsewhere. Undergraduate students typically find writing in a reflective mode extremely challenging and therefore need plenty of practice and valuable feedback to improve.

Feedback in language learning environments is normally either **un-coded correction** (where the correct forms are written for each error) or **coded annotations** (where symbols are used to aid self-correction). (Sampson, 2012) and (Ahmadi et al., 2012) term these as code feedback and non-coded, direct correction feedback. Whilst these two authors arrive at contradictory conclusions as to which type of correction constitutes the most useful feedback – both are agreed that a combination of the two is probably the most beneficial. (Bitchener & Knoch, 2009) suggest that direct **corrective feedback** may be augmented by written and/or oral linguistic explanation. However, for the particular study group, no conclusive results were obtained. (Ellis et al., 2008) makes a very strong argument based on a

study of focused and unfocused written corrective feedback, concluding that such feedback is effective regardless of the focus.

The debate between **corrective and non-corrective feedback** continues vigorously in the language learning arena. Although these studies emphasise the use of feedback for essays or narrative produced by language learners, results and good practice here could be helpful in providing feedback for other situations where considerable written work, such as business reports, system documentation, user guidelines and specifications, is to be examined.

Reflective writing is a core skill requirement in many professions such as Medicine and Health. (Reis et al., 2010) propose a framework for use by academics when providing systematic feedback to enhance reflective competence. In recent years, students from all disciplines have been encouraged to add to their professionalism by acquiring good reflective writing practices. (Reis et al., 2010) advocate the highlighting of the "learner's salient quotes and key concepts" as well as "expressed emotions" when crafting feedback.

Written assessment allows for student individuality and allows the practice (and subsequent assessment) of writing style which is a useful transferable skill, although the drawbacks of subjectivity and time consumption could counter-balance the advantages. Many students in Higher Education, perhaps particularly in the Sciences and perhaps particularly International, are ill-equipped to tackle a written assignment with confidence and flair. Effective feedback for such students is especially important.

2.3.4 Use of technology

Technology can improve assessment quality and it can also support diversity and accessibility. Recent years have seen an increase in the ways in which technology has been used to enhance the student experience of receiving feedback. Technological solutions to feedback provision include: adaptive e-learning environments, neural computing, web-based environments, video and audio technology, augmented reality; as well as the more traditional online MCQs and

quizzes, and feedback blogs and online forum feedback. Sophisticated mobile and hand-held devices also open up alternative possibilities of feedback provision which may be more readily acceptable to present-day students.

Within the technology-assisted assessment and feedback environment there is a profusion of examples which utilise all manner of technology. Developments in **computer-based assessment** (CBA) have gone from entire simulation environments being developed, to building strategies for personalised feedback that is matched to learning goals and performance. Ong (2007) suggests the automation, through intelligent software, of assessment and feedback through the use of simulation-based training. Papamitsiou & Economides (2013) believe that the focus on learning goals is important in the CBA situation. Nix & Wyllie (2011) carry out a project which aims to increase the motivation of learners and also to give them the ability to self-regulate their CBA learning experiences. This project implemented and analysed the perception of interesting features such as a confidence indicator tool, a learning log and a question feedback. One unexpected finding of this project was that learners' often do not read onscreen feedback.

E-learning (web-based learning, distance learning, online learning) systems are generally better able to support active and adaptive learning. Researchers in this area share the consensus that just as teaching and learning processes can be adaptable, so can the feedback. Vasilyeva et al. (2008) examine the tailoring of feedback in relation to learning style preferences which can be ascertained by the responses given to an online test. Su-Sui & Kwo-Ting (2008) found that e-learning students were primarily concerned with high-quality levels of learning interaction and only secondarily concerned with online assessment and feedback. Miller et al. (2010) design web-based learning environments to highlight the value of technology-mediated feedback and e-assessment.

Others, such as (Jordan & Mitchell, 2009), have explored **natural language** based systems to author assessments which require short, free-text answers given online, with tailored, detailed and instantaneous feedback. Wu et al. (2012) consider the role of concept maps for organising knowledge; they propose a computer-based

concept mapping system with the ability to immediately evaluate a concept map developed by the student and also give real-time feedback.

Schilling (2013) makes use of **video feedback** for what he terms 'visual learners' in the computing field. He argues that written feedback is the prevailing norm because it is simple to provide, but that students generally do not read it. He advocates the provision of video feedback which can include an aural commentary and dynamic visuals which demonstrate the assessment process. Crook et al. (2012) also make use of video technology with advantages to both staff and students, with a particular increase in student engagement.

Use is made of **self-video recording** techniques by Masip-Alvarez et al. (2013) to explore the assessment of generic competencies such as oral and written communication and teamwork. The aim here is to encourage students to not only evaluate their own activities but also their participation in group activities.

MacGregor et al. (2011) experiment with **audio feedback** in the form of 'voice emails' and obtains results which indicate an enhancement to the student learning experience but no gains in student performance as a consequence of having audio feedback available for reuse and replay. Whilst Srinivasan et al. (2009) advocate a joint audio/video system particularly suitable for distance learning and arrives at an assessment matrix for evaluating quality of feedback.

A system developed by Wang (2013) caters for situations where students are not able to ask for assistance from their tutor or from peers face-to-face. The system works on **mobile smart devices** and is able to give different levels of feedback to students who ask questions online in a chat room format, thereby aiding and progressing their learning. This 'Answering Robot' is capable of instant questioning and answering, but it is not clear what is the students' perception.

Engagement of learners through the various evolutions of the internet (from web 2.0 to web 4.0) and mobile devices is a popular current research topic and there are some good examples of classroom-based activity. For example, Khristin & MacLean (2014) use mobile tablets as an assessment intervention in Further Education

classrooms. Lauricella & Kay (2013) explore the usage levels of **text and instant messaging** with tutors and with peers; concluding that both are a useful communication tool in Higher Education. Lewis & Rush (2013) employ a case study to explore the use of microblogging (Twitter) for academics in Higher Education, but the study does not cover use in assessment or feedback. Sharkawy & Meawad (2009) use mobile in-hand messaging for instant feedback in HE classrooms to encourage participation and increase attendance. Isabwe et al. (2013) use media tablet technology for mathematics assessment in Norway and Rwanda to encourage peer assessment and feedback.

These examples are interesting in that they could potentially lead to newer assessment styles – but then, newer ways of providing feedback will also be required. The use of mobile devices promises to keep students engaged, but whether they can assist effectively in delivering quality feedback is unclear. Traxler (2012) discusses the progress of mobile learning and contends that educational institutions will have to look outward and to the economic and political forces currently in play.

Other examples are more focussed on the use of technology for the provision of feedback. Moridis & Economides (2012) investigate the use of affective feedback in the form of students taking an online self-assessment test and receiving an applause sound for a correct answer. Research into feedback which considers the ways in which emotional factors come into play for different genders and different cultures has not been fully explored. Chen, N. et al. (2013) make use of smartphones to enable constructive feedback which brings together mobile devices and physical textbooks by using **QR codes and hyperlinking**. Lai's (2010) study of whether Taiwanese learners prefer the feedback on their essays from peers or from a computer program shows that the former was more generally opted for. Technology is used in a **dialogue-based cognitive tutoring** system by Hung et al. (2014) to actively engage learning in research methods. The dialogue metaphor enables participatory interactions between the system and its users.

Happy et al. (2013) highlight the need for an automated system to provide feedback on the basis of emotional and alertness states of learners. In this system, **visual**

cues such as facial expressions and gestures contribute to the system being aware of the cognitive state of the learner; thereby giving appropriate feedback.

Overall there has been relatively little coverage of how the use of technology can help us understand what students actually do with the digital feedback.

2.3.5 Educator preferences

Educators have available to them a vast range of feedback mechanisms, but most prefer to use only a small subset of them. Preference choices are most likely based on experience, expertise, knowledge and confidence of technology and subject area. In attempting to categorise feedback types, the preferences of those giving the feedback needs to be observed. In fact, the preferences of those receiving the feedback should also be considered.

Bailey & Garner (2010) conjecture that teachers have varied perceptions and beliefs about the purposes of written feedback, and are uncertain about what it achieves and what use students make of it. Far from enhancing written feedback, innovative practices and procedures have created new problems for teachers. There is a clear need for continuing research in this area. Parr & Timperley (2010) argue that teachers require considerable teacher **pedagogical content knowledge** in order to be able to provide the necessary feedback – this is based on a study which measures the quality of response to a written piece of work. Govaerts et al. (2013) suggest that when it comes to providing quality feedback, the subject expertise of the assessor has little bearing. In his study of different levels of assessor expertise amongst GPs, he found that varying levels of expertise did not affect feedback quality. They conclude that coaching "on the job" is a continuous requirement for assessors, regardless of their level of expertise.

Evans & Waring (2011) conducted a study of student teacher **cognitive preferences** with a view to suggesting best practice for these new educators which takes into account their cognitive styles and gender. The resulting framework, Personal Learning Styles Pedagogy, could enhance assessment feedback practice.

Carless et al. (2011) call for the development of sustainable feedback practices and highlight the importance of student self-regulation. Whilst Brown et al. (2012) found that in New Zealand schools, teachers are more concerned with improving learning (and therefore performance) than with improving the well-being of their students. Cultural and institutional preferences may need to be examined when considering teachers' perceptions of the feedback they give. Further, Irving et al. (2011) refer to one of the main purposes of feedback to be encouragement, as well as being about learning, grades and marks, or behaviour and effort.

There appears to be a difference in the approaches of educators from different institutional sectors in how they prioritise students' welfare. Educators in schools and colleges of further education are perhaps more mindful of the effect their feedback has on the emotional and psychological state of their students. What is evident from the diverse range of educator adoption levels of certain feedback practices is that it is challenging to form an overall judgement as to best practices. The novice educator therefore has to navigate the dense forest of current feedback practices in order to arrive at something which is workable for them.

2.3.6 Student audience

When providing feedback, it is necessary to contemplate the potential variation in the student cohort. Variations in the types of feedback provided for University and College students would presumably be different to those provided for primary and secondary School pupils. There may also be **cultural diversity** and variations in **study patterns** of differing ethnic groupings to consider. Individual ability and self-confidence will play a prominent role in the manner in which feedback is sought, digested, assimilated and applied for improvement. The hypothesis here is that an individual's **existing skill base** will predetermine the use they can make of feedback. Students pursuing different disciplines will also add to the variation: science students may be assessed differently to humanities students and each will utilise feedback on the basis of their evaluative prowess gained elsewhere in their studies.

Havnes et al. (2012) cite **gender differences** in perceptions of assessment and feedback in schools (which may or may not be prevalent in HE). Interestingly, they note that students get more useful feedback from vocational training than from academic modules.

Cotner et al. (2008) consider students in **large classes** who need preparation for examinations and finds that classroom response systems (clickers) are a student-appreciated form of providing rapid feedback. Whilst Bloxham & Campbell (2010) experiment with interactive cover sheets as a format for initiating a dialogue in the form of questions posed by students to which tutors give feedback. The study concluded that students had a limited understanding of tutor expectations which may have hindered a more meaningful dialogue.

The use of **self-reflection** in making the most of given feedback is advocated by Sargeant et al. (2009). This qualitative study found that the reflection process aids assimilation and acceptance of feedback. Of course, students have to possess a degree of maturity to be able to engage fully in self-reflective practices in order to then avail themselves adequately of given feedback.

Cramp (2011) identifies **first-year degree students** for whom a general intervention at the time of their very first written feedback provided to them for various modules can be used to best effect. Ferguson (2011) conducts a study of undergraduate students and their perceptions of what feedback should be. Students identified preferences about the format, the level of detail and the timing of feedback on assessment. Robinson et al. (2013) find that students' feedback experiences prior to HE may impact their ability to positively engage with feedback given as first year undergraduates.

The feedback provided to **international postgraduate students** studying in the UK is considered by Tian & Lowe (2013) and they conclude that assimilating and utilising feedback in the early months may pose cognitive challenges and psychological and emotional struggles for these students. Tian & Lowe (2013) see the usefulness for feedback provision for this student group as potentially acting as a cultural bridge which can aid enhanced learning.

A review of research conducted by Jonsson (2013) focusses on attempting to find out how students use feedback. One interesting issue that arises is that students may not possess the right strategies for utilising feedback. For example, they may use it in an ad hoc or **passive manner** and not in any clear constructive way.

It is of note here that undergraduate perceptions of feedback may differ significantly from those of postgraduate students, who have the benefit of possibly being exposed to feedback mechanisms for a longer duration.

2.3.7 Peer and self-assessment

The role of peer and self-assessment models and the subsequent feedback opportunities has been trialled in various contexts and particularly with online discussion forums. Pre-university students are conceivably not familiar, and therefore not confident, with the use and practice of such assessment. Perera et al. (2010) see the importance of peer and self-assessment in an objective way and trials a system to **improve communication skills** – an area where such assessment is potentially very applicable. Strom & Strom (2011) applies a teamwork inventory of skills and uses peer and self-evaluation techniques to allow team members to consider the benefits and drawbacks of working within the team. Thompson & McGregor (2009) consider the use of online peer and self-assessment for group work, making use of a ratings system which proved valuable when the anonymity of the raters was assured.

Willey & Gardner (2009) have developed a system (SPARK) to conduct online peer and self-assessment. They highlight the need to augment this type of assessment with collaborative **peer learning activities**. Xie (2012) regards behaviour in **online discussions** with peer feedback as a possible indicator of student learning and finds that motivation and peer feedback can be used to predict posting and non-posting behaviours.

Experiments conducted by Strijbos et al. (2010) investigate the type of peer feedback (concise or elaborated) and the competency (high or low) of the feedback giver. Interestingly, those that received **concise feedback** from their peers outperformed

those that received elaborate feedback. Li et al. (2012) and Li et al. (2010) consider the importance of the role of assessor as well as assesse and concludes that both are required for effective technology-facilitated peer assessment.

Graduates who completed homework exercises in an online peer feedback environment, were less concerned with scores than with specific feedback which they could use to make improvements (Lui & Lee, 2013). Whilst Van der Pol et al. (2008) found a notable relationship between feedback containing **concrete suggestions** and the successful acceptance of that feedback.

Wasson & Vold (2012) uses the advantage of new media skills which encourage **informal community interactions** in the production of a peer feedback tool with the aim that it will be more readily accepted and used.

The barriers to successful uptake of peer feedback are noted by Poverjuc et al. (2012) to be a **lack of exposure to peer feedback** practices and the questioning of the peer's ability to give valid feedback. Topping et al. (2013) conduct an interesting experiment with school children located in Spain and England, where they were grouped so that each individual has an opportunity to be a tutor and a tutee. Although the aim was for students to make improvements in both roles, there was in fact a seesaw effect here.

Self-assessment and self-evaluation can be valuable ways to enhance learning and this practice can be beneficial long after an individual has completed formal education. However, researchers find that students often significantly over-rate or under-rate themselves. Hall & Vance (2010) uses **self-explanation** and combines it with peer feedback, but with no clear findings.

2.4 Conclusions from Review

The literature review has highlighted the significant number of feedback practices currently in use. The main conclusion reached at this point is that in order to gain a sound of understanding and appreciation of the most effective feedback types, some

structuring, ordering and weighting of types is necessary. Although detailed reviews of current literature have been conducted (Evans, 2013), (Gabelica et al., 2012), (Hepplestone et al., 2011) and (Gikandi et al., 2011) there remains a requirement to perform a systematic categorising of feedback. The NSS results (Section 2.2) consistently show that whilst students are generally satisfied with the assessment instruments and their arrangements, students are less satisfied with the effectiveness of feedback methods. A review and categorisation of feedback methods is therefore a viable approach to the consideration of feedback effectiveness as a whole.

2.4.1 Features of Effective Feedback

At this point, it is useful to summarise the predominant features of feedback as discerned from the review of current practices; particularly what might constitute valuable feedback:

- Quantity (of comments and evaluation of performance)
- Diversity (correct answers, explanations, hints)
- Directly relevant (to the performance of given assessment task)
- In language that is well understood
- Clear signposts and hints for improvement
- Authentic (from respected party)
- Usefulness to individual (for development)
- Both positively and negatively critical

There is a generally held view that some form of verbal feedback would be beneficial in any situation. There is also the benefit of group versus individual feedback to be considered. Also under consideration is the level and relative ease of attaining feedback assimilation skills and whether these can be taught, learnt and applied.

Sancho-Vinuesa et al. (2013) advocate the use of immediate feedback to a continuous set of activities in order to optimise student engagement. Dube et al. (2012) also see the advantage in continuous assessment where feedback at each interval is “clear, specific and constructive”. Orsmond & Merry (2011) suggest that feedback should be better aligned, so that tutor intentions and student perceptions

coincide more effectively. They suggest that tutors make use of scaffolding and also vary their feedback.

Brookhart (2011) argues that feedback is effective only if it is customised to the learner's needs, with struggling students needing different feedback to successful ones. Whilst Broquet & Punwani (2012) acknowledge that certain types of learners, for example, those for whom English is a second language may have to overcome cultural barriers in order to "participate in feedback inquiry, self-reflection and reciprocal feedback", in order to fully gain from feedback received. The use of technology to enhance the levels of effectiveness of feedback is used by Vincelette & Bostnic (2013) in the form of screencasts which enable the instructor's thought processes whilst assessing, fostering a transparent interaction between student and instructor.

From reviewing the literature and from my own teaching experience, it is evident that feedback is more likely to be acted upon if the following set of conditions prevail:

- The feedback giver is empathetic, trustworthy and knowledgeable
- A variety of modes of feedback are available
- Multiple ways of feedback delivery are used
- Feedback is accurate, specific and focussed to a small set of goals
- Feedback is both positive and negative but always constructive
- The learning style of the learner is considered
- Allow students to take a more active role in their learning
- Indicates clearly how improvements can be made.

Evans (2013) crystallises the principles of effective assessment feedback practice in a concise, but extremely thorough, table (pages 80-83); the main sections of which are listed here in verbatim form:

- Feedback is ongoing and an integral part of assessment
- Assessment feedback guidance is explicit
- Greater emphasis is placed on feed-forward compared to feedback activities

- Students are engaged in and with the process
- The technicalities of feedback are attended to in order to support learning
- Training in assessment feedback/forward is an integral part of assessment design.

Ensuring that all these practices are in place in their entirety is a taxing and prodigious feat and one that is extremely challenging to achieve.

2.4.2 Newer areas of feedback practice

Feedback practices have evolved, and continue to evolve and shape the teaching and learning horizon. One area that has perhaps not been given as thorough coverage as others is the assessment and feedback of entrepreneurial and workplace skills. Much of modern education is steeped in the acquisition of skills that will strengthen the employability prospects of learners. The embedding of work-related, work-based and project-based (Hosseinzadeh & Hesamzadeh, 2012) components into the academic curriculum means that newer forms of assessment and feedback will be necessary.

Technology-assisted approaches to feedback provision also continue to evolve as the technology itself evolves. There is scope here to further mesh practices and utilise a variety of technologies in harmony.

However, in any context the cultivation of a learning culture where feedback is a valuable and significant part of learning and where both learners and tutors are trained in utilising feedback skills is the ultimate aim

2.5 Summary

This chapter reports on an extensive review of the current usage of assessment feedback practices. Since the volume of available literature in this area is so vast, pertinent themes have been identified. Table 2.4 summarises the significant practices that have been discussed in the literature review.

Table 2.4 Thematic Summary of Assessment and Feedback Practices

Theme	Practice
Subject disciplines	Portfolios, online assessment, computer-assisted feedback, language learning feedback
Assessment types, methods and tools	Project-based assessment, exemplars, multiple lenses, diagnostic, formative, summative, norm-referenced, criterion-referenced, interim feedback
The written context	Un-coded correction, coded annotation, corrective and non-corrective feedback
Use of technology	CBA, self-video recording, audio feedback, mobile smart devices, QR codes, visual cues
Educational preferences	Pedagogical content knowledge, cognitive preferences, personal learning styles
Student audience	Cultural diversity, study patterns, skill base, large classes, passive recipient
Peer and self-assessment	Online discussions, collaborative peer learning, community interactions, self-explanation

Within these themes coverage of interesting and diverse experiments, studies and interventions has been included in order to make a case for the need to perform some systematic work, by the development of a taxonomy of feedback, in identifying some of the best common practices.

3. Development of a Taxonomical Classification of Assessment Feedback

3.1 Introduction and Motivation

The literature review in the previous chapter has emphasized the vast array of feedback practices which have evolved in all educational sectors over the past decade. Literature reviews play an important part in surveying scholarly output within a particular area of research and providing a critical and summary evaluation of what is currently available in the literature. However, it is the role of a taxonomy to systematise a field so as to provide a useful framework for practitioners; the best example being Bloom's Taxonomy of Education Objectives (Bloom et al., 1956) which has been utilised by educationalists and researchers for decades.

What is been proposed is the definition and development of a taxonomy of feedback which will allow the investigation of combinations of feedback practices. The rationale for developing a taxonomy of feedback is to provide a systematic reference of the various types of feedback with associated criteria. The aim is for the taxonomy to aid in the highlighting of under-utilised or overlooked feedback types with a view to discerning any hybrid formats to further improve the effectiveness of feedback. The taxonomy will also support the identification of weak or under-performing feedback types as well as distinguishing any missing elements. The taxonomy will take into account the contextual suitability and sensitivity of feedback.

Categorising feedback on student assessments can be problematic as much depends on the variability of educator preferences, student engagement and assessment types. In particular, educator preferences where tutors do not wish to modify practice or embrace new technologies can be a barrier. On the other hand, student engagement with feedback can be erratic, with students often not understanding the feedback they receive. In addition, certain assessment types lend themselves to particular types of feedback opportunities whereas others do not.

3.2 Developing the Taxonomical Classification

Taxonomy is the practice and study of the classification of concepts and their underlying structure. Controlled vocabulary, taxonomy, thesaurus and ontology are mechanisms which allow this classification to be undertaken. The terms taxonomy and thesaurus are sometimes used interchangeably, but strictly, the former is a broader to narrower view and the latter then augments this hierarchical view further by defining relationships. Ontologies provide increasing complexity by additionally characterising the specification of terms in several differing ways for a given universe.

In terms of the development of taxonomical structures in the assessment and feedback areas, recent examples include (Ali et al., 2013), (Ben et al., 2008), (Coleman et al., 2009), (Diefes-Dux et al., 2012) and (Terrion & Leonard, 2007). However, these examples attempt to categorise very particular elements only, such as computer-based critiquing tools, adaptive feedback, group supervision, formative assessment for mathematical modelling problems and the characteristics of student peer mentors. The present taxonomy development will not restrict itself to specific elements – but will attempt to arrive at a general, higher level classification of all major feedback types, situations and their features.

Of particular note is the taxonomy of feedback, shown in Figure 3.1, as suggested by Chetwynd & Dobbyn, (2011) which characterises feedback according to whether it relates to skills or content and whether it is retrospective or future-altering.

Content	*Retrospective-on-content*	*Future-altering-on-content*
Skills	*Retrospective-on-skill*	*Future-altering-on-skill*
	Retrospective	**Future-altering**

Figure 3.1 Chetwynd & Dobbyn's taxonomy of feedback

Within this taxonomy, marking guides are used by tutors to give feedback on student submissions where retrospective feedback notes are made on-script and future-altering feedback is given on a separate summary sheet. Future-altering feedback points forward explicitly to future work, stating and justifying the skills that are to be developed through the course of assessment. Chetwynd & Dobson also state that "….[feedback] should also refer back to those skills developed and tested in earlier assignments, thus encouraging students to (re)read, and perhaps even make use of, the feedback they had received earlier". (p. 77).

The present taxonomy development will be more detailed and will incorporate all aspects of providing feedback and will also encompass all the various contexts, such as use of technology, feedback platform and feedback situation, in which this is done.

3.2.1 Construction Method

An empirical evidence-based method of developing a taxonomy will be utilised, where the main input is the literature review conducted and discussed in the previous chapter. The taxonomy will be formulated by investigating current popular practices which have evolved during the last decade. The majority of coverage will focus on Higher Education, but both Further Education and Secondary School education could yield interesting facets. The intention is to take an all-encompassing perspective, which does not disregard any subject disciplines, assessment methods or tools. The feedback taxonomy cannot be completely exhaustive as activity and practice, and therefore the number of publications (as exemplified in the literature review), in this field is particularly buoyant. However, it is comprehensive in that all contexts have been covered and any ambiguity minimised. The construction will encompass two main stages, namely taxonomy creation and taxonomy evaluation which will include taxonomy testing and validation.

3.2.2 Taxonomy Creation

As a starting point, and to further emphasise the extremely broad and diverse nature of feedback practices, we begin by randomly enumerating, in Table 3.1 some possible feedback types and terms, as characterised in the current literature. The feedback practices have been represented in a two-columned manner but do not signify any pairings.

Table 3.1 Illustrative List of Feedback Terminology

• peer-to-peer, learner-to-learner	• audio / video feedback
• self-feedback	• AI-assisted feedback
• group feedback	• adaptive feedback
• e-feedback	• web-based feedback
• feedback on feedback	• augmented reality feedback mechanism
• direct / indirect feedback	• summative feedback
• instant feedback mechanism	• developmental feedback
• feedback in blended learning	• error correction feedback
• technology-facilitated feedback	• commentary feedback
• performance feedback	• self-assessment as feedback
• explicit / implicit feedback	• fast feedback
• evaluative / corrective feedback	• discursive feedback
• feedback on activity-led approachs for groups	• externalised feedback
• verbal feedback	• response-driven feedback
• written feedback	• synchronous feedback
• formative feedback	• e-written feedback
• internal/external feedback	• actionable feedback

Taxonomising is hindered by the diversity, the overlap, the multiplicity and the contextual applicability of each feedback term. Certain feedback types can be immediately viewed as a category – for example, all those that make direct use of technology, such as augmented reality, web-based, adaptive, AI-assisted, VLE-based, audio and video; others however cross multiple groupings such as verbal feedback

and corrective feedback. In addition, some feedback terms are synonymous whilst the meaning of others is dependent on context.

In light of this apparent diversity of feedback terminology, six main categories are formulated: assessment tool, feedback platform, feedback type, feedback situation, feedback format and purpose of feedback.

Assessment tool

The actual assessment tool or method has a huge impact on the nature of feedback provision available. Feedback styles on a written report submission, for example, differ vastly to the feedback given on a computer programming assignment, as do feedback for unseen examinations, portfolios, log books or oral presentations.

Feedback platform

The platforms utilised for feedback can be broadly distinguished as either technology-facilitated or not. Technological solutions open up a wide variety of possibilities, although they still have to adhere to conventional best practices related to learning.

Feedback type

The envisaged intention of the feedback, whether it be diagnostic in nature or summative or formative is an important consideration which can dictate the timing that feedback can be given. Norm-referenced feedback compares a student's performance with other students, whereas criterion-referenced feedback compares performance to a standard or criterion.

Feedback situation

As assessment situations can take many forms, from group to self to peer-to-peer, so the feedback situation should also ideally be represented in these groupings.

Feedback format

Marking proformas and annotations are the predominant ways in which to provide feedback on almost all categories of assessment.

Purpose of feedback

The two main purposes of feedback are to enhance performance and to aid learning and self development.

The resulting taxonomy (Figure 3.2) depicts these six main categories.

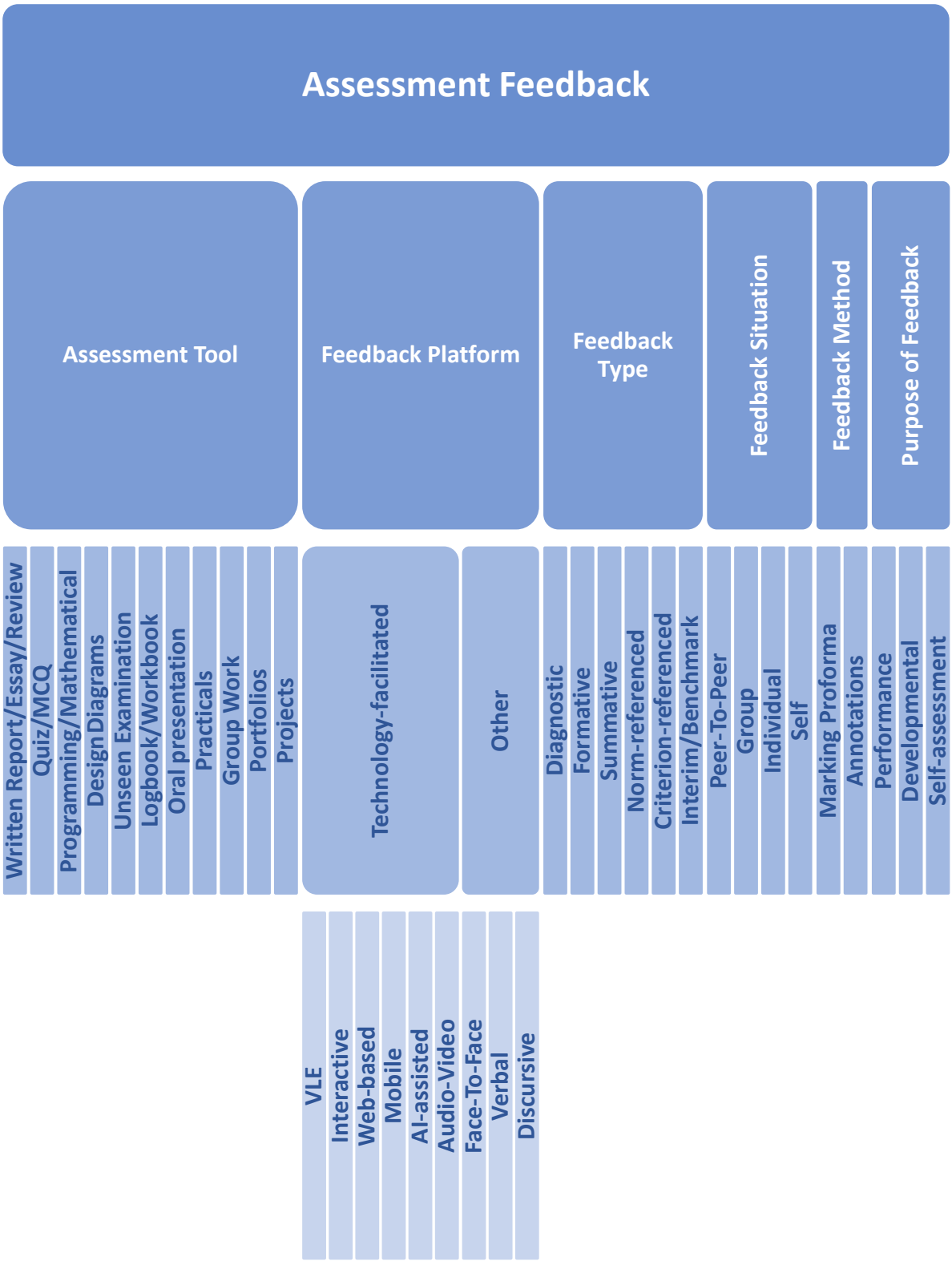


Figure 3.2 Preliminary Taxonomical Classification of Feedback

3.2.2.1 Finalising the Taxonomy

A taxonomical view is commonly hierarchical by nature, but in terms of the categorisation required here, a forced hierarchical perspective is not useful. Therefore, the classifications have been levelled as each is perceived to have equal contribution within a particular category.

We have added a new category, labelled Context, to encapsulate the practical environment which was missing previously.

Context

The contextual environment has a bearing on the mechanisms available for providing feedback, for example, a feedback style adopted within a physical classroom-based activity may not necessarily be appropriate for a distance-learning environment.

Within this category, the contexts of Distance Learning, Work-Related Learning and Work Placements often require specialised and, to a degree, more innovative methods of feedback provision. Also, in the category Purpose of Feedback, the self-assessment element has been renamed to self-learning in order to distinguish it from developmental feedback which is seen to be the seeking of short-term and specific improvement, whilst self-learning would be of longer duration and more comprehensive. Figure 3.3 gives the final taxonomical classifications with these significant amendments.

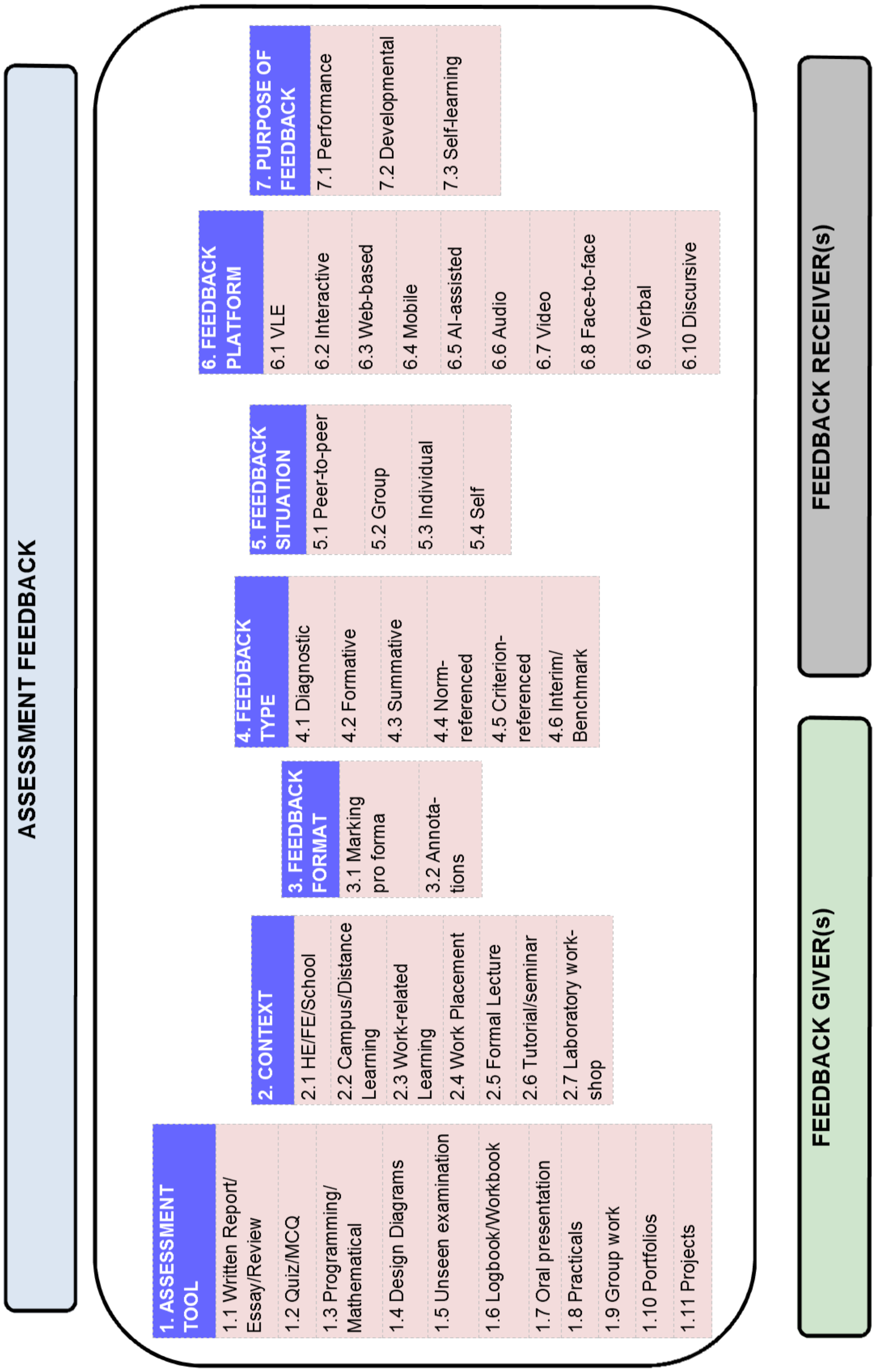


Figure 3.3 Final Taxonomical Classification of Feedback

3.2.3 Taxonomy Evaluation: Selecting Dimensions and Settings

We now proceed with some evaluative work to further authenticate and validate the classifications. Evaluating feedback types requires the determining of dimensions which can be used to cross-reference and refine the understanding of the practice of certain types of feedback. In the current frame of reference, an initial determination of aspects such as effectiveness, adoption, satisfaction, quality, quantity, authenticity, context, impact, relevance, constructiveness and assessment type are considered.

The choice of exactly which dimensions to include was governed by the requirement to appreciate, from the student's point of view, exactly how effective and well-received a certain feedback type was. The challenge of choosing these particular dimensions is one of neutrality. The evaluation of feedback needs to progress in a non-biased manner where the goals of students and tutors coincide. The four dimensions, as shown in Figure 3.4 and described subsequently, of effectiveness/impact, satisfaction, adoption/engagement and quantity were selected to evaluate the taxonomy.

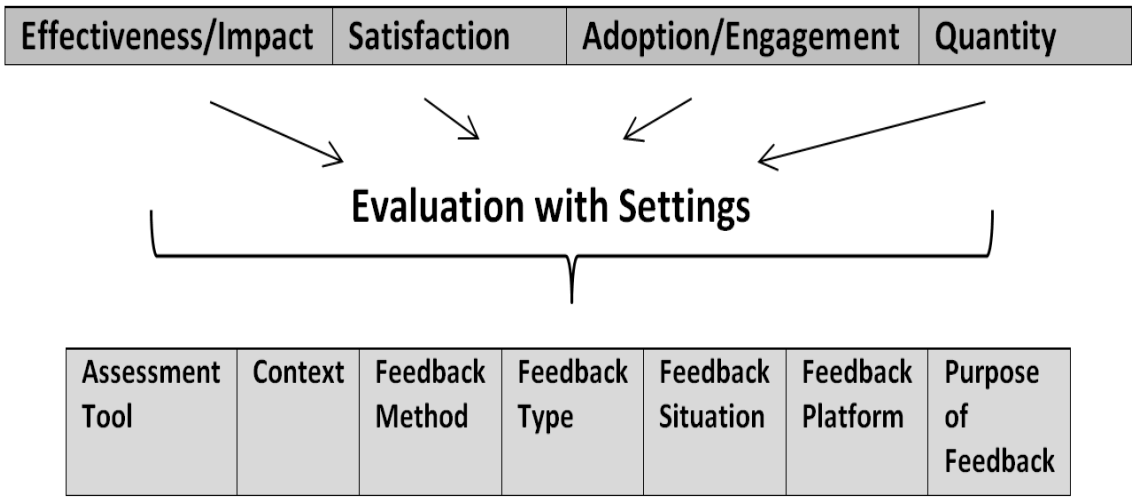


Figure 3.4 Evaluation of the Taxonomy using Dimensions and Settings

Effectiveness/Impact

Student perceptions in this dimension are expected to be two-fold: on the one hand feedback provides students with performance-related information and on the other hand feedback facilitates task improvement and general development. The feedback would have a higher impact if students are able to use it to identify their strengths and weaknesses and as a consequence be able to improve performance.

Satisfaction

Feedback can be seen to be a factor in the quality of student experience with several positive aspects such as confidence-building, enhancing motivation and increasing self-esteem. However, feedback can also have unpredictable and negative effects where students feel demotivated and unable to make use of the feedback. Students' perceived satisfaction would be higher where their expectations were being fulfilled.

Adoption/engagement

The level of engagement with feedback can be related to the student's approach to learning (such as deep, surface, strategic or apathetic learning) and all learners will adopt feedback depending on their own learning style. Active engagement with feedback can enhance lifelong learning by enriching powers of reasoning and refining meta-cognitive skills. However, adoption of feedback is generally only increased if it is directly related to improvements in performance. In any case, feedback styles should seek to maximise adoption levels by ensuring clarity, accuracy, relevancy and also positivity.

Quantity

The granularity or size of feedback given can have an effect on the way it is consumed or assimilated by students. The 'chunking' of feedback is important to ensuring acceptable cognitive loads and allowing students to concentrate on crucial information.

Next, we move to a stage of systematically grouping elements of the taxonomical classification, as shown in Figure 3.3, into a series of settings. Each setting is made

up of 3 or 4 search terms which have been chosen to weave through the literature in a more unexpected way than was done in the literature review. Here we wish to elicit some added-value in the sense that settings can be made to be interesting by combining moderately unlikely feedback features together in a single setting. For example, a setting which is made up of the search terms 'assessment', 'feedback', 'higher education' and 'essay' yields a resulting 49 articles, which may give some insight into feedback practices for essay writing that students may possibly have become accustomed to prior to entering higher education.

A total of 10 settings were compiled and each setting's terms were entered into an advanced search to the Educational Resources Information Center (ERIC). From the resulting list of articles, a small subset (usually between 3 to 4, although one setting warranted 6) was selected for scrutiny on the basis that:

1. The articles were published after January 2010.
2. Assessment feedback (rather than student feedback) was to be the focus.
3. The articles related findings primarily from empirical studies with some insight into student perceptions.

Initially it was thought that the articles' content could be weighted or somehow quantitatively measured according to the dimension – for example, for any particular setting, a score (perhaps on a rating of 1 to 5) for each of the four dimensions 'Effectiveness', 'Satisfaction' 'Adoption', 'Quantity' could be given and then a final result score could be calculated by summing these. However, there are problems of measuring in this way since there can be a degree of arbitrariness of weightings. Also, the meaning of a resulting weighting would be insignificant unless it was accompanied by further qualitative descriptions. Therefore, given the discursive nature of most of the findings and also given that the goal was to tease out and arrive at a series of properties or characteristics which could define effective feedback, a qualitative approach was taken to record key features within each article according to the four dimensions.

Ten feedback settings were formulated, each with a minimum of 3 search terms – the first two of which in every case were to be 'assessment' and 'feedback'. Table 3.2 shows the ten settings along with those articles that were selected for further study.

Table 3.2 Ten Feedback Settings with corresponding articles

Feedback Setting	Selected articles
Setting 1: assessment AND feedback AND higher education AND essay 24 results – 4 selected	(Court, 2014), (Smith, 2014), (Tomas, 2014), (Wakefield et al., 2014)
Setting 2: assessment AND feedback AND formative AND group 99 results – 5 selected	(Clark, 2012), (El et al., 2012), (Jessop et al., 2014), (Lipnevich et al., 2014), (Suen, 2014)
Setting 3: assessment AND feedback AND further education or school AND self 133 results – 3 selected	(Liu et al., 2015), (McMillan & Turner, 2014), (Tay, 2015)
Setting 4: assessment AND feedback AND presentation 51 results – 3 selected	(Barry, 2012), (De Grez et al., 2012), (Faherty, 2015)
Setting 5: assessment AND feedback AND portfolio 71 results – 6 selected	(Chang & Wu, 2012), (Lam, 2014), (Offerdahl & Impey, 2012), (O'Sullivan et al., 2012), (Romova & Andrew, 2011), (Shepherd & Bollinger, 2011)
Setting 6: assessment AND feedback AND technology AND lecture 23 results – 4 selected	(Enriquez, 2010), (Voelkel, 2013)
Setting 7: assessment AND feedback AND work-related learning 1 results – 1 selected	(Clements & Cord, 2013)
Setting 8: assessment AND feedback AND distance learning AND technology 15 results – 3 selected	((Chetwynd & Dobbyn, 2011), (Hughes et al., 2014), (Rogerson-Revell, 2015)
Setting 9: assessment AND feedback AND mathematic* 180 results – 5 selected	(Broughton et al., 2013), (Chauhan, 2014), (Hudesman et al., 2014)
Setting 10: assessment AND feedback AND audio 26 results – 5 selected	(Carruthers et al., 2015), (Gould & Day, 2013), (Hennessy & Forrester, 2014), (Munro & Hollingworth, 2014), (Rodway-Dyer et al., 2011)

3.3 Thematic Discussion

There now follows a detailed discussion of the findings of the scrutiny of the articles in each of the ten settings. The discussion is serviceably themed according to the four dimensions as this allows for cross-referencing, cross-checking, comparison and summary.

3.3.1 Dimension: Effectiveness/Impact

Student perceptions in this dimension are expected to be two-fold: on the one hand feedback provides students with performance-related information and on the other hand feedback facilitates task improvement and general development. The feedback would have a higher impact if students are able to use it to identify their strengths and weaknesses and as a consequence be able to improve performance. Several studies (for example, (Court, 2014)) have found that a mixture of written and verbal feedback given without grades in the first instance improves the chances of that feedback being taken seriously by students.

Lipnevich et al. (2014) controversially trialled the use of non-individualised feedback in the form of a detailed rubric and exemplars acting as feedback to large groups of students. The onus is left to the student to assess his or her work against the detailed rubric and exemplars. In this way, it is hoped that students could identify the extent of the gap between what they have submitted and where they need to be in order to improve performance. Tay (2015), on the other hand, finds that her "… authentic illustrations [exemplars] appear to offer learners more help than rubrics in facilitating self-evaluation" (p. 15).

General skill development, particularly for those students close to graduation, requires the alignment of assessments with desired outcomes (O'Sullivan et al., 2012). Within the portfolio assessment system used by O'Sullivan, students are engaged throughout the course and develop their electronic portfolios incrementally and "As a consequence, they are constantly referring to the graduate capabilities in class and discussions with their advisors." (p. 389).

Voelkel (2013) states that for feedback to be effective it needs to be timely and ensures this with the use of a two-stage test design, where students receive prompt (and formative) feedback on the first test, success on which progression to the next stage is determined. Voelkel's aim was to "encourage and provide personal feedback in large classes" (p. 1). Online testing, such as that used by Voelkel, can be a powerful tool for formative assessment and also provide several opportunities for immediate feedback. Enriquez (2010) also makes use of technology in the form of tablet devices to give students real-time feedback during a classroom session, which had a positive effect on quiz and homework scores.

Chetwynd & Dobbyn (2011) scrutinise the use of marking guides as used by tutors on distance learning programmes and find that they should ideally include future-altering feedback particularly where students' skills deficiencies can be identified and fed-back on.

Students in Carruthers et al. (2015) study of the effectiveness of receiving audio feedback found that those students liked the timeliness of this type of feedback and also liked the ability to re-access it whenever they wished. Further, the work of Gould & Day (2013) shows that "students valued audio feedback as [being] more detailed, personalised and supportive than written feedback". (p. 554).

Indeed, all the studies (the above two and also (Hennessy & Forrester, 2014), (Munro & Hollingworth, 2014), (Rodway-Dyer et al., 2011) included in this setting, report a high degree of effectiveness and positivity with audio feedback.

3.3.2 Dimension: Satisfaction

Feedback can be seen to be a factor in the quality of student experience with several positive aspects such as confidence-building, enhancing motivation and increasing self-esteem. However, feedback can also have unpredictable and negative effects where students feel demotivated and unable to make use of the feedback. Pat El et al. (2012) explore how ethnic differences influence the motivation of students when they learn from formative feedback. They find that where a tutor's feedback is more

extensive and supportive (as with a scaffolded approach), this results in a greater intrinsic motivation on the part of the student.

Citing (Black and Wiliam 2009, p.11), Clark (2014) agrees that "formative interaction" between tutor and student gives light to tacit knowledge which is gained through discussion, reflection and experience. Clark states that "effective feedback…….occurs when learners are encouraged to articulate their tacit knowledge" (p.209). Clark hypothesises that students with a strong sense of self-efficacy make better self-regulated learners who can plan, monitor and evaluate not only their learning but also the manner in which they assimilate and apply formative feedback. Self-regulated learning is promoted by Lam (2014) through the use of portfolio assessments which allow for iterative feedback processes. Lam suggests that "The use of formative feedback during the portfolio process can ……. promote self-regulated learning by helping students to uptake the feedback information for subsequent revisions". (p. 701).

Positive feedback in the form of applause during an online self-assessment test was found by Liu et al. (2015) to be particularly important to the improvement of students' learning states of male students. Gender-neutral strategies for feedback which cater for both male and female students are something that tutors need to be aware of.

School students' perceptions were elicited in a study conducted by McMillan & Turner (2014) which sought to understand the perceptions of assessment and feedback as they relate to learning and motivation. McMillan & Turner find that "Students were not distressed if their answers were wrong due to a misunderstanding or not knowing a concept, but motivated to study more to learn the content" (p. 34).

Faherty (2015) studied the impact that summative peer assessment and feedback may have on enterprise learning outcomes and found that "Study participants valued the experience and considered that it enables them to learn from the successes and failures of others…" (p. 299). De Grez et al. (2012) also find that "The results [of a study which focuses on the agreement between professional assessment and self- and peer assessment of oral presentation skills] also reflect a very positive

attitude of students towards peer assessment as a relevant source of external feedback" (p. 129).

A range of e-vities utilising technologies such as voice-based discussion boards, podcasts, wikis and blogs designed by Rogerson-Revell (2015) have enhanced "support and [provision for] constructive, formative feedback, from peers as well as tutors" (p. 135). Students on a work-based distance-learning programme in Rogerson-Revell's study "described how they found the interactivity of the tasks stimulating and how it motivated in-depth discussions on topics". (p. 135).

3.3.3 Dimension: Adoption/engagement

The level of engagement with feedback can be related to the student's approach to learning (such as deep, surface, strategic or apathetic learning) and all learners will adopt feedback depending on their own learning style. Active engagement with feedback can enhance lifelong learning by enriching powers of reasoning and refining meta-cognitive skills. However, adoption of feedback is generally only increased if it is directly related to improvements in performance. In any case, feedback styles should seek to maximise adoption levels by ensuring clarity, accuracy, relevancy and also positivity. Wakefield et al. (2014) cite previous work which highlights the differing levels of engagement with the feedback process between high-achieving students and non-high-achieving students. The study, utilising an essay feedback checklist conducted by Wakefield et al., aims to aid both types of students on achieving higher attainment in future assessments. This transferability of achievement to alternative (future) assessments is an important facet of good feedback.

Tomas's (2014) study of the marking and feedback provision on an essay-based coursework highlights the two-fold construction of feedback which can be utilised in several types of coursework, namely the focus on detailed aspects of the student submission (usually with annotations and corrections) and the focus on providing a general summary or synoptic feedback to the student. This dual approach, which many tutors take, can facilitate maximum adoption by students.

Many studies have attempted to maximise the engagement of students in the feedback process; Smith (2014) does this with an online peer review assignment where students upload topic content which can then be commented upon by peers. This type of immediate peer feedback in an online environment facilitates a community learning approach where feedback is seen to be constructive.

Suen (2014) advocates the use of peer feedback within a MOOC environment and addresses the challenge of ensuring a higher degree of credibility of peer feedback by calibrating raters, after some initial training, and devising a credibility index for all raters.

Voelkel (2013) encourages engagement with a formative assessment by providing prompt and regular feedback on weekly online tests. Students then follow a two-stage online test design, where the second test can only be taken if students achieve 80% in the first test.

The self-assessment of video recording and viewing of group presentations in Barry's (2012) study engendered "levels of reflection observations, which allowed students to reflect and feed forward the potential for improvement on any future performances" (p. 859). Individuals, when assessing their own performance in the group video, often marked themselves lower than their peers; showing the gap between perceived performance and actual realised performance.

The use of portfolios as a beneficial vehicle for assessment is well established. However, the additional benefits of hosting the portfolio in an online, web-based environment provide greater opportunities for tutor, self and peer feedback. Chang & Wu (2012) make use of a web-based portfolio assessment system in which focus is placed on a detailed rubric which raters use for assessment and feedback. Shepherd & Bollinger (2011) make use of Google sites as a platform for students to create e-portfolios, in which they found that embedded prompts and tutorials, as well as some direct tutor coaching was necessary feedback that provided guidance and clarification.

The recursive mechanisms used by Lam (2014) during portfolio assessment "…trigger the creation of self-generated feedback, namely internal feedback for further engagement with the interim drafts collated for the portfolio". (p. 703). This type of

engagement is vital for self-regulated learning to take place and furthermore if it is practiced by students regularly it can even instil a lifelong learning capability.
Romova & Andrew (2011) also make use of portfolio assessment with a focus on providing a reflective space. The study ".. emphasises that when students are actively engaged in reflecting on the difficulties and challenges involved on their learning, they gain a deeper appreciation …….". (p. 120).
Hughes et al. (2014) believe that written feedback that is simply 'given' to students does not motivate engagement. Hughes et al. propose "that an [self-referential] ipsative approach to .. feedback based on a comparison with a learner's previous performance motivates distance learners by developing a self-awareness of progress that encourages learners to interact with feedback and apply this to future work". (p. 31).

Hudesman et al. (2014) champion the concept of developmental feedback and state that "Being able to provide students with ongoing feedback about the relationship between their actual performances (their quiz scores) and their predicted scores, and the relationship between their preparation time and their self-efficacy and self-evaluation judgements) is critical to improving students' … skills sets", (113).

Learner styles and preferences are individual and therefore a more tailored approach to feedback may be necessary. Gould & Day (2013) conclude that ".. students should be encouraged to experiment with their learning styles" (p. 563) as audio feedback does not suit all learners.
Clements & Cord (2013) put forward ideas, such as e-logs, learning modules and reflective journals for the design of assessments which develop graduate skills of students on an experiential programme. Whilst these types of assessments could be adopted more readily by students during their internship, there is no mention of the types of feedback they receive.

3.3.4 Dimension: Quantity

The granularity or size of feedback given can have an effect on the way it is consumed or assimilated by students. The 'chunking' of feedback is important to ensuring acceptable cognitive loads and allowing students to concentrate on crucial information. In Court's (2014) study of tutor feedback on draft essays, some students viewed the quantity of feedback as having a detrimental impact which affects their ability to redraft the work on the basis of the voluminous feedback given on draft assessment. Court's iterative feedback on several contiguous draft submissions may, for some students, have led to the overwhelming-ness of the feedback quantity.

Jessop et al. (2014) discuss the wide variations in the quantity of feedback students could expect. For the courses they investigated, they found that it took between 10-35 days for students to receive feedback, that there was 15 times more written feedback in some cases than others and that oral feedback ranged from 37 minutes on a science course to 30 hours on a work placement.

Peer feedback in online situations, such as MOOCs (Suen, 2014) or Wiki video viewing (Barry, 2012) is perhaps not as constrained by quantity as in traditional settings, possibly because in most cases it can be prompt, easier to publish and respond to.

Offerdahl & Impey (2012) acknowledge the challenge of managing the practical aspects of the large volume of student work contained within a portfolio assessment. Portfolio content needs to evidence and demonstrate a student's capabilities and their achievement of specific learning outcomes. In Offerdahl & Impey's study "…..a minimum of eight pieces of student work per portfolio, a rigid schedule for the collection, critiquing, and return of portfolio pieces was necessary to ensure continuous feedback to students." (p. 21). This continuous feedback takes an iterative form with students adding drafts to the portfolio and receiving comments in the following week.

3.4 Conclusions

The taxonomy evaluation has given further insights into the manner in which students perceive feedback.

Recurring common themes around the most effective types of feedback centre on self-regulated learning, with much agreement in the literature that where such developmental and personalised feedback is given, the chances of students being able to self-regulate themselves and actually assimilate and apply the feedback is much higher. It is acknowledged that self-regulation is not an easy learning skill to acquire as it requires meta-cognitive awareness, autonomy, strategic action in the form of planning, monitoring and evaluation, and above all else a motivation to learn. Developmental and continuous feedback cycles appear to be the kinds of feedback that can yield the most long-term benefits for students. Feeding forward is a concept that is synonymous with development as it involves students in determining how feedback relates to their own understanding and about ways to apply the feedback in future situations.

Another common theme is that of the provision of regular formative feedback which is motivational and digestible (in terms of quantity) is the most useful. However, there is common agreement that students need to be active rather than passive recipients of feedback and one popular method of engagement is that of peer review.

The evaluation has highlighted an area which has had very little attention and that is the type of feedback provision which is conducive in the experiential learning domain in general and in the work-related learning area in particular.

3.5 Summary

The main findings of the novel taxomomical classification developed here and its subsequent evaluation, namely the significance of developmental feed-forward guidance with which students can self-regulate themselves, will underpin subsequent work on further investigations into how assessment and feedback

provision can support the Work-related learning context. There appears to be a gap in the provision of pedagogic studies to support feedback opportunities for Work-related learning. We need to better understand the role that Work-related learning has to play in developing students and also what type of feedback during this learning experience will be most beneficial to the preparation for professional employment.

4. Feedback Scoping Study within a Work-related Learning Context

4.1 Introduction

In the preceding chapter a feedback taxonomy was developed which allowed the classification of feedback types to be considered. An area that appears to have received very brief coverage is the feedback opportunities used to effectively assist students during Work-related learning experiences.

Much of modern education is geared towards the acquisition of skills that will strengthen the employability prospects of learners. The past decade has seen the fortifying of employability skills acquisition into Higher Education programmes in all subject disciplines. On the one hand, the priority placed by students on developing generic, transferable and work-related skills as an integral part of their academic study in order to enhance their employment prospects has never been higher. On the other hand, employers continue voicing their strong concerns over graduates who are lacking necessary problem-solving, business communication and team-working skills required in the workplace. These dual demands have been responded to by the HE sector with the introduction and embedding of several Work-related learning initiatives into the academic curriculum.

However, these initiatives can often be mechanical with little thought given to what particular skills are being practiced and how individuals can be supported to improve them. Therefore, more work is needed to establish the feedback practices and also individual perceptions of skills which are pertinent to Work-related learning experiences. Consequently, this scoping study aims to arrive at an initial view of these perceptions.

4.2 Work-related Learning

The concept of work-readiness has come to mean framing the academic curriculum with as many opportunities for gaining the experience of work as possible and thereby developing those employability skills that industry demands of new

graduates. The embedding of work-related, work-based and project-based components into the academic curriculum has meant that transferable skills so valued by employers are able to be practiced and assessed.

Firstly, we begin with terminology, in particular the terms 'work-related learning' and 'work-based learning' which are often used interchangeably. Work-based learning is often perceived to be that learning which is practiced and accumulated within an employment context. In this sense, this type of learning continues for as long as an individual is in a work-place. European government-driven initiatives aim to recognise and give credit to work-based learning as an alternative to purely academic qualifications. Work-related learning usually tends to happen from within an academic-driven environment where students practice and acquire professional awareness and apply technical skills. The practice environment for work-related learning need not necessarily be within an actual employment – it can be, for example, in a virtual business environment. In any case, neither of these terms normally includes block work placements, internships, distance learning or evening classes. In addition, both terms are also encompassed by the much more generic term 'work experience'.

Venables & Tan (2009) describe work-related learning as a form of experiential learning where students learn through their experiences rather than from direct transmission of material. The term work-related learning is sometimes used to mean that learning which is developed and experienced in the workplace, Simons & Ruijters (2008); possibly outside an academic programme. This is seen to be a form of training and is perhaps better termed work-based learning, where the learning experiences arise directly from the work tasks to hand.

Work-related learning initiatives are particularly predominant in the computing, science and business disciplines where most take the form of a module with a work placement opportunity and a series of assessments, for example Clements & Cord (2013). Many programmes include such a module in the final year of study, whereas McKinnon & McCrae (2012) believe that work-related activities should be embedded into the first-year curriculum in order to allow for early exposure to the benefits of

enhancing employment skills. The work of Jollands et al. (2012) on project-based learning for engineers gives an insight into how 'aspects of undergraduate experiences assisted with their transition into the workplace'. Graduates (and their managers) were interviewed to ascertain their work-readiness in a number of skills including project management, problem solving and communication. The study explores the degree of work-readiness but does not examine the use of assessment feedback and how that was understood and deciphered by the recipient and which elements have direct applicability and effectiveness to workplace tasks. Hopkins (2008) places emphasis on engaging with college leavers in order to learn how they experience the benefits of work-related learning.

Learning has many facets: theory, experience, reflection, practice and social interaction. Lappia (2011) acknowledges that all these elements should ideally come into play during a work-related learning arrangement. Additionally, learners also learn effectively by the type of feedback they receive, including explicit improvement indicators. Although Clements & Cord (2013) highlight the importance of choosing assessment methods with care, there is little evidence as to the type of feedback, and the effectiveness of it in the preparation of new graduates, which has been provided on their 'experiential learning programme'. Initiatives such as CDIO (Conceive-Design-Implement-Operate) for engineers and PBL (Project-Based Learning) for medical scientists have forged the path to actively instilling experiences of workplace requirements into the academic syllabus.

Rowe & Wood (2008) conclude that assessment feedback as a motivator is particularly well received by students. Jessop et al. (2013) report that students on a programme with a work placement receive significantly more oral feedback. One useful method of feedback provision involves self-assessment and reflection, but Jackson (2014) finds that when it comes to undergraduates assessing their own capability of employment skills there can be varying degrees of over and under rating.

Given the prominent emphasis on work-related learning within the HE curriculum, there appears to be insufficient coverage of feedback mechanisms which are directly

relevant to assessment and practice in the work-related learning context. The exploratory hypothesis for a proposed scoping study described below is that current feedback practices in this area lack rigour and precision and should ideally reflect those used in mainstream commercial and public industry sectors.

4.3 Context and Funding for the Scoping Study

With the apparent lack of investigation of work-related learning experiences, a successful funding application was made to the Association for Learning Development in Higher Education (ALDinHE)[3] which is a professional body representing members' views in response to Government and other agency initiatives. ALDinHE is for "Learning Developers [who] share a common desire to empower students in their learning through helping them make sense of academic practices within higher education and supporting them to acquire the generic underpinning skills for the environments in which they are working".

Funding for a small-scale study encompassing these values was sought and made available in November 2014. The study's main aim is to understand the relationship between learning development in the last stages of an undergraduate's academic journey and their first experiences of employment. The study seeks to determine the extent to which newly employed graduates are able to readily apply their learning from the assessment and feedback given on a work-related learning module embedded into the final year of their degree programme. Focus is to be placed on the module assessment feedback provided, how that was understood and deciphered by the recipient and which elements have direct applicability and effectiveness in their workplace tasks. The main outcome will be an insight into graduates' perceptions of feedback received during participation in the module and what (if any) actual use they have been able to make of it. This awareness can then be used to enhance current feedback practices to be more in line with the rigorous and competency-based approaches utilized by many employers.

[3] Association for Learning Development in Higher Education www.aldinhe.ac.uk

By comprehending what students have understood by the feedback provided for them whilst they were learning and experiencing work within a safe University environment and how able this has made them in the actual workplace, it will be possible to enhance feedback practices particularly in terms the negotiation of learning agreements.

4.4 Methodology

Activity comprising of survey research methods to elicit experiences from new graduates began in January 2015. In this scoping study an online survey questionnaire and semi-structured interview methodology have been employed to elicit opinion and commentary on the extent to which assessment criteria and the feedback received map onto the participant's ability to perform work tasks.

The online survey is designed to re-engage the new graduates and remind them of their experiences on completing assessment on a work-related learning module. The survey, Appendix A, was developed using a widely available free online cloud-based survey service. The survey was kept necessarily brief (10 questions) to generate as much interest as possible.

A follow-up interview was based on a semi-structured question framework with opportunity for open-ended discussion. Interview participants were encouraged to describe workplace practices with examples where possible and also to make comparisons between their work-related learning experiences and their current work experiences.

Graduates from the 2014 cohort of three computing degree programmes who had completed a work-related learning module were included for participation. The online survey was responded to by 41 leavers out of 84. In hindsight, this was not the best time of the year to administer a survey of new graduates about their work experiences as it coincided with the national Destination of Leavers from Higher Education (DLHE) survey which usually reaches a peak during January.

4.4.1 The Work-related Learning Module

Students on a Computing related set of undergraduate programmes undertake a six-month work-related learning module whose main aim is to enhance and extend their learning experience by applying academic and technical skills to tackling real life problems in the workplace. At the start of the module, all students develop a learning agreement in conjunction with stakeholders such as private clients, clients in the voluntary and charity sectors, mentors, academic tutors and supervisors. The learning agreement specifies the way in which learning outcomes will be developed and how they will be evidenced. The assessment tool is a learning portfolio which comprises of a weekly learning log, employer evaluation, a business report with supporting evidence/artefacts and a final presentation/demonstration. Feedback mechanisms used include criteria-based written comments from the employer and also annotations on the portfolio report by the tutor. Verbal feedback is given during the final presentation, which also includes an element of peer feedback. Students often work in teams and it is possible for second year students to work alongside third year students.

4.5 Results and Findings from the Scoping Study

The responses to the online survey and subsequent interviews give an indication of the benefits and the potential gaps in the Work-related learning experience. Survey questions based on the improvement of skills as a direct result of the Work-related learning module were posed. The results give some insight into the perception of graduates at that important transitional period of leaving the university educational environment and spending 6+ months in the workplace. However, it is the individual interviews that have shed further light on other aspects of the perceptions of graduates in the workplace.

The first part of the survey required participants to rate their effectiveness at six core skills. This set of skills broadly mirror the set of 'transferable' skills used by the National Union of Students (NUS), except that we have included 'Professional

Conduct' instead of 'Numeracy' as this was seen to be more pertinent to the Work-related learning context.

In the next section, we discuss the results of responses to questions which asked participants to rate their effectiveness at the six core skills: *before* taking the work-related module, *after* taking it and at their *current* workplace. Effectiveness is presumed to occur as a result of learning development and utilisation of feedback given on the module. In general, there is a marked improvement in skills acquisition and enhancement during the Work-related learning module, with the most significant improvement coming from the practice of teamwork skills throughout the module. This is reassuring as that is one of the main learning outcomes of the module. More interestingly though is the perceived improvement of several other skills at the workplace, in particular organisation and time management. Professional conduct appears to be an area needing more focus within the module, as it is only in the workplace that respondents relate an improvement in this aspect.

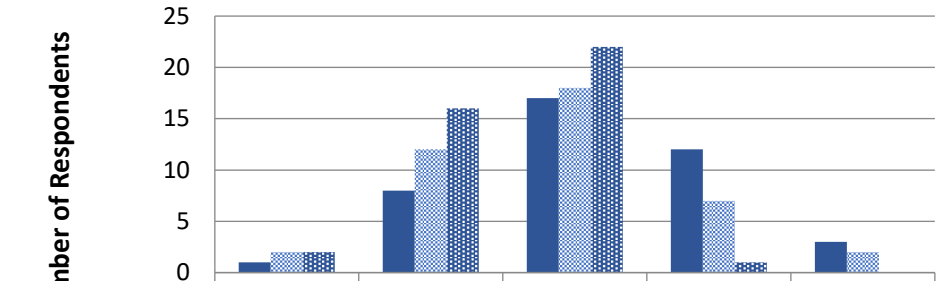
4.5.1 Survey Results

We now discuss the results of responses (41 in total) to the survey questions relating to skills acquisition.

Communication and Interpersonal skills

These skills would have been practiced repeatedly during the module, with verbal and written communications with clients, employers, tutors and peers; and culminating in a formal presentation.

Therefore, an improvement during the module is to be expected, but in this case, there is a further and marked improvement, shown in Figure 4.1, beyond the module; 73% responded in the 'good' and 'very good' categories after the module, which rose to 93% in the workplace. Graduates relate that the positive feedback they received during the module resulted in them becoming more confident and competent in this skill in the workplace.

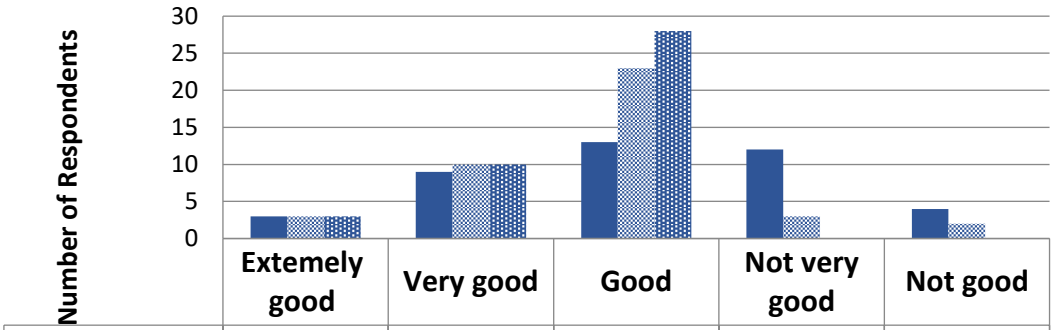


	Extemely good	Very good	Good	Not very good	Not good
Before WRL	1	8	17	12	3
After WRL	2	12	18	7	2
At workplace	2	16	22	1	0

Figure 4.1 Effectiveness at Communication and Interpersonal skills

Teamwork skills

These skills appear to have improved dramatically during the module, as depicted in Figure 4.2, but showed barely any change thereafter. Many participants comment that although they are part of a team (varying from 2-8) in the workplace they have not yet had an opportunity to contribute fully and have instead being allocated manageable tasks to be completed under supervision. This suggests an underdeveloped knowledge and experience of what it means to be a member of a team, making a contribution to its overall achievement by completing designated tasks to a high standard and in a timely manner.

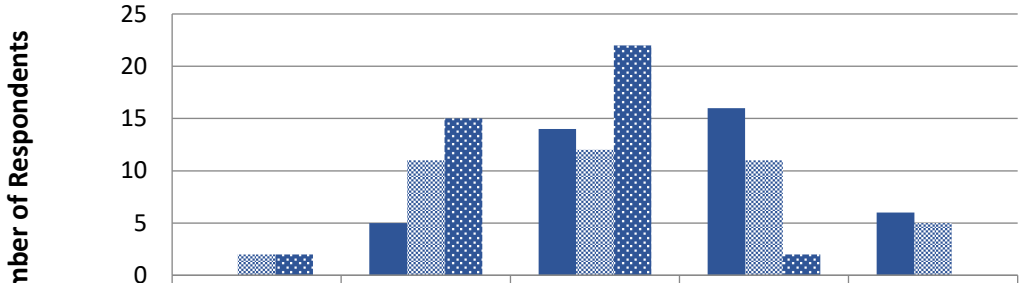


	Extemely good	Very good	Good	Not very good	Not good
Before WRL	3	9	13	12	4
After WRL	3	10	23	3	2
At workplace	3	10	28	0	0

Figure 4.2 Effectiveness at Teamwork skills

Initiative and Problem-solving skills

These skills showed the most movement in ratings with half of all respondents moving from the 'not very good' category at the end of the module to the 'good' category at the workplace, as shown in Figure 4.3. This result may be attributed to the prominence given during the undergraduate programme to mastery of these skills as being extremely desirable to potential employers. Some participants comment that they were formally tested on these skills during the job selection process; others relate their experiences of having to answer questions in this area during a job interview. These skills have a heightened interest for computing graduates as their perception is that is what employers are particularly interested in.



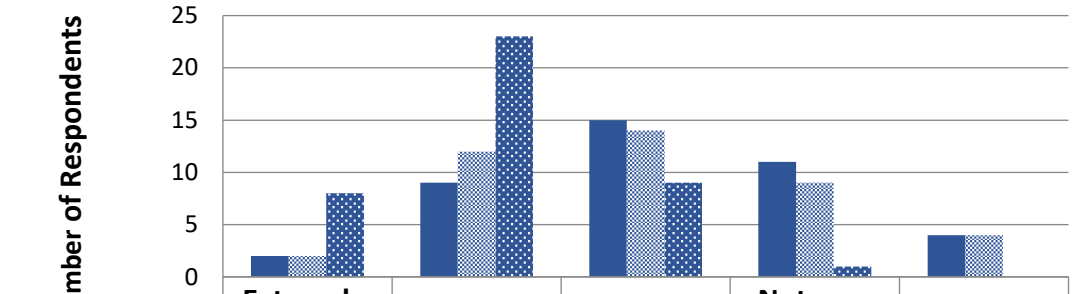
	Extemely good	Very good	Good	Not very good	Not good
Before WRL	0	5	14	16	6
After WRL	2	11	12	11	5
At workplace	2	15	22	2	0

Figure 4.3 Effectiveness at Initiative and Problem-solving skills

Organisation and Time Management skills

These skills have the most noticeable movement (Figure 4.4) in terms of respondents' perception of how effective they have become at them in the workplace. In part this may be explained by the fact that several graduates were either on temporary contracts or paid hourly which may have enabled them to structure their time more effectively in order to meet deadlines. During the interview stage, several participants related that they surprised themselves at how

they had made these skills a priority when commencing employment, whereas they had given them very little thought during University life.

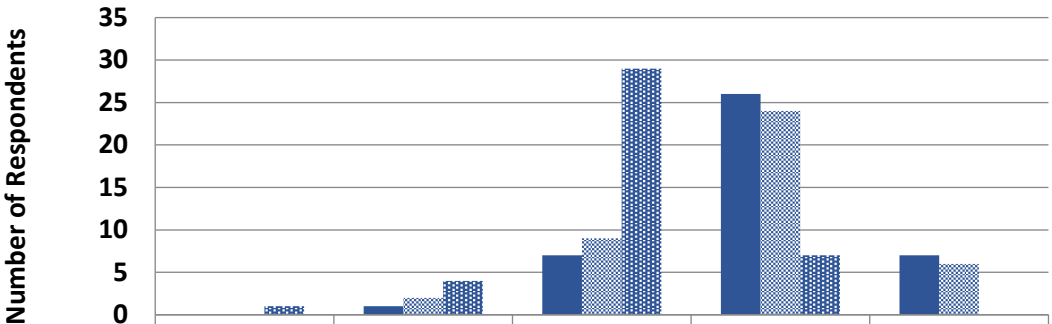


	Extemely good	Very good	Good	Not very good	Not good
Before WRL	2	9	15	11	4
After WRL	2	12	14	9	4
At workplace	8	23	9	1	0

Figure 4.4 Effectiveness at Organisation and Time Management skills

Professional Conduct skills

During the module, respondents were not very good (80%) at these skills and there was very little improvement during the module, as can be seen in Figure 4.5. However, in the workplace that belief had been minimised to just 17%. Workplace induction and initial training may have attributed to this improvement. During the module, skills in this area related to student awareness of codes of dress, behaviour expectations, confidentiality and diversity.



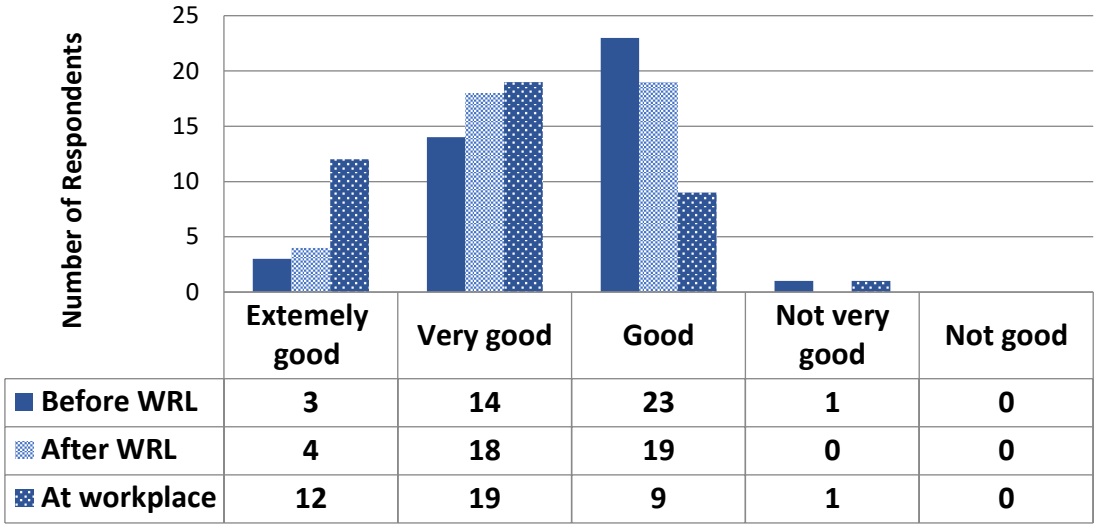
	Extemely good	Very good	Good	Not very good	Not good
Before WRL	0	1	7	26	7
After WRL	0	2	9	24	6
At workplace	1	4	29	7	0

Figure 4.5 Effectiveness at Professional Conduct skills

Jollands et al. (2012) pinpoint a work-readiness skill termed ethical considerations which in their study was found to be sometimes misunderstood by both graduates and their managers. Understanding professional and ethical implications and how to apply them appears to be an area that requires more attention – something which professional bodies can help with. Trustworthiness is not only difficult to measure but is also challenging to teach, learn and feedback on – yet it is a competency that many employers require.

Information Technology skills

A considerable improvement is shown (Figure 4.6) in all categories here, particularly in the response that indicates that participants felt they are 'extremely good' at this skill in the workplace. This could be the result of training provided by the employers or sustained practice within the organisation's IT environment.



	Extemely good	Very good	Good	Not very good	Not good
Before WRL	3	14	23	1	0
After WRL	4	18	19	0	0
At workplace	12	19	9	1	0

Figure 4.6 Effectiveness at Information Technology skills

Comparing Effectiveness of all skills

Figure 4.7 shows the movement between the 'Not Very Good', 'Good' and 'Very Good' categories across the six skills and highlights the following interesting student perceptions of their effectiveness at the skills:

Communication and interpersonal skills effectiveness moves from 'Good' to 'Very Good' for the majority. This improvement also applies to those who were 'Not Very Good' at the beginning of the work-related learning module.

Although Teamwork skills improve over time (from the beginning of the module through to employment), the majority of students feel they are 'Good' at this skill whilst only a quarter of students rate themselves as being 'Very Good' at teamwork.

Initiative and problem-solving skills show a very noticeable improvement from the beginning of the module to current employment status. Three times as many students rate themselves as 'Very Good' at problem-solving in the workplace as they were at the beginning of the module.

Organisation and Time Management skills show the highest rating in the 'Very Good' category at the workplace of all the six skills. This skill is also rated comparatively very highly in the 'Extremely Good' category at the workplace.

More students felt 'Not Very Good' at professional conduct skills during the module than any other skill and by a very significant degree. The picture changes considerably though at the workplace, with 29 out of 41 students rating their capability of professional conduct in the workplace as 'Good'.

Effectiveness at Information Technology skills were rated by the majority of students in the higher categories, with almost half of all respondents rating themselves in the 'Extremely Good' category.

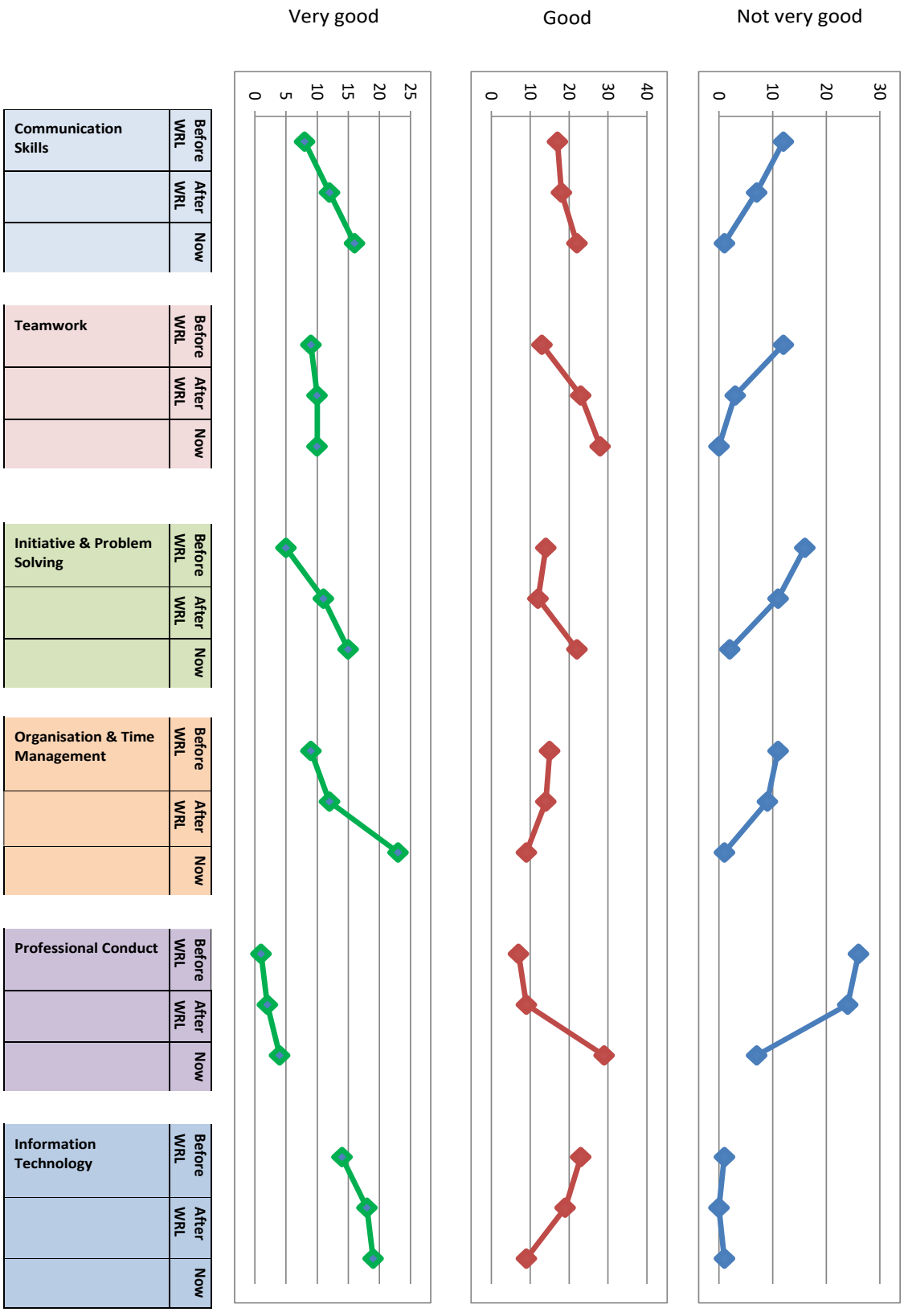


Figure 4.7 Improvement and Effectiveness of the Six Skills

Skills Ranking

The survey also asked participants to rank each of these six skills in the order of which feedback during the module has helped most in the workplace tasks. Feedback provided on communication and interpersonal skills was regarded as being the most useful, whilst the feedback related to professional conduct was found be the least useful. Professional conduct, it seems is best learnt within the workplace.

In the context of the work-related module, respondents preferred feedback to be either verbally provided or as short comments on their work. They preferred not be given feedback as a group or even a small team and less than half the respondents placed value on the final grade as a means of valuable feedback.

4.5.2 Interviewing Results

The interviewing process was based on a series of semi-structured questions to cover those aspects in the workplace that were challenging and to gauge the extent to which the feedback given during the work-related learning module helped or is helping. The most overwhelming aspect to arise from these discussions was the stark difference in feedback given to assessment and the feedback given in terms of performance and capability at work. All participants, even those that were employed on a temporary or voluntary capacity, felt strongly that they had not been prepared for receiving what was sometimes felt to be quite harsh and very direct feedback on their performance at work. A number of respondents had undergone a formal appraisal process and perceived that nothing at university had prepared them for it. Examples of aspects of appraisal processes which graduates would not have come across typically include objective-setting with targets and stretch targets, financial as well as non-financial objectives, accountabilities and goals, key indicators, self-assessment and forward-looking development plans.

Another area that caused some concern is around the terminology for competencies used widely in industry. Participants believed that they did not have a clear understanding of how to evidence competency and therefore were unable to

adequately relate their abilities to employers. Examples of desirable competencies used by many organisations including a prominent magic circle employer, include 'cultural awareness and sensitivity', 'resilience', 'following through', 'business alignment', 'judgement' and 'influence'. Participants felt that some awareness of the language of competency as utilised in industry could have been usefully included in the work-related learning module.

All participants related a considerable difference in their experience of the work undertaken for the work-related learning module itself (even where it was for an industry-based client) and the work they were now doing at the workplace; with many citing the 'pressure to produce' as being infinitely more challenging in the workplace.

4.6 Summary

The scoping study has revealed that Work-related learning when embedded into the academic curriculum does play an important role in allowing students an environment in which to acquire, practice and improve their employability skills. However, it appears that new graduates remain inexperienced and under-exposed to dealing with feedback given during the Work-related learning module in order to actually transfer their transferable skills to the workplace. This may be a fault with the feedback process, with its focus on measurement of effectiveness of learning outcomes in particular and student performance in general, itself and its inability to propel and move forward to goal attainment incrementally. One important reason why students may not heed feedback comments is that they are not able to appreciate how that feedback will allow improvements in learning and ultimately performance in later assignments, or in this case, to workplace tasks. The concept of feed-forward may therefore be more valuable for Work-related learning development than the more common feedback strategies. Students should ideally be exposed to setting their own targets and stretch targets within a more direct and formalised feed-forward environment; thereby developing a degree of maturity in students. It is evident that negotiated learning agreements as used in Work-related

learning initiatives need further enhancements to align them better to the performance measuring tools used in industry.

Current feedback practices appear to be deficient (as evidenced by the lack of studies found during the taxonomy evaluation in Chapter 3) within the Work-related learning context. The impact of feedback appears to be not fit-for-purpose in the workplace.

We conclude from the scoping study results that a deeper investigation is required to consider the manner in which students can be better supported in the practice of competency-building, with a more impactful feedback format, during Work-related learning.

5. Competency Frameworks

5.1 Introduction

The preliminary investigation and scoping study, described in previous chapters, has revealed a need for further examination of feedback practices in the Work-related learning context, specifically the role of developmental feedback (or feed forward) within a professional competency framework. The concept of 'competency' has materialised outside the higher education system to characterise an individual's set of skills and proficiencies that are relevant to employability. The term competency can be defined according to its primary purpose and we cite the following as it encompasses the developmental aspect that relate to our research:

> A cluster of related knowledge, skills, and abilities that affects a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved through training, development, and experience.[4]

The language of competency is heavily utilised by employers when considering staff selection, appraisal, continued professional development, technical training and development. However, students and new graduates are not proficient in this language and therefore face challenges when entering the employment market.

Several models have been introduced to enhance the so-called process skills and competences by stimulating students to apply their knowledge. For example, project-led education (PLE) uses team-based activity to solve complex large-scale open-ended problems whereas problem-based learning (PBL) uses structured teams solving smaller-scale tasks. In addition, CDIO (conceive, design, implement and operate) is an engineering education model which aims to close the gap between engineering science and engineering practice; and also, strives to engender a sense of engineering professionalism. These initiatives provide a mechanism for defining

[4] Training Magazine, July 1996

academic curriculum and practices but they do not establish assessment methods and certainly not assessment feedback practices.

(Bennai et al.) focus on a PBL pedagogy to utilise a repository of competencies against which learners are assessed. Bennai uses the repository for the ongoing evaluation of the learner's skills during three stages, namely pre-assessment, formative assessment and post-assessment. It is not clear how the competencies are assessed and what forms of assessment can be used. Also in the formative assessment stage, the feedback appears to take a performance-related guise for phases of the project that students are undertaking.

Rivera-Ibarra et al. (2010) arrive at a competency framework for software engineers by defining ten roles (e.g. programmer, test engineer, analyst) for which the competencies of technical, social and personal are measured. Ducrot and Shankararaman (2014) have developed a useful competency framework for an Object-oriented Application Development course which facilitates the setting of assessment and the provision of feedback (in the form of grades) by the course team. However, there is no evidence given as to how the competencies have been arrived at, and it appears as though they equate to course content; certainly, they do not appear to be derived from any particular professional competency framework. Similarly, (Sedelmaier & Landes, 2014) have developed a framework for assessing students' competencies of a software engineering capstone project. Here again there appears to be little alignment to a professional framework.

Competency frameworks have also been proposed for other professions such as the conservation-restoration profession (Hutchings & Corr, 2012), border officers (Qing et al., 2011), medical records officer (Jamaluddin et al.,2014) and Enterprise Resource Planning (Scholtz et al., 2012). In addition, competency frameworks have been developed for the purposes of informing curriculum design for HEIs and development processes for organisations (for example, (Krause et al., 2015), (Johnson & Ulseth, 2014) and (Orsoni & Colaco, 2013)), but these lie outside the main focus here which is to consider the use of competency frameworks for assessment and feedback.

5.2 Professional Competency Frameworks

Competency frameworks exist in virtually all professional and employment sectors, but are particularly prolific in science, medicine, engineering, computing and IT, where they are often aligned to continuing professional development and certification. Professional bodies such as Institute of Engineering and Technology (IET), BCS The Chartered Institute for IT, Health and Care Professions Council (HCPC), British Medical Association (BMA), UK government bodies such as the Department for Business, Innovation and Skills (BIS) and not-for-profit organisations such as Tech Partnership often seek to define and innumerate the standards by which professionals should work.

As a starting reference point, in the following sub-sections, we describe three examples of professional competency frameworks readily available for the various professions of Information Technology, Cybersecurity and Information Management – namely the SFIA, NICE and IISP frameworks. These particular frameworks were selected as being representative of the IT industry that graduates of Computing-related degrees would enter.

5.2.1 SFIA

The Skills Framework for the Information Age (SFIA)[5] is the UK Government and British Computer Society (BCS, The Chartered Institute for IT) backed competency framework which describes IT roles and associated skills. SFIAPlus contains the SFIA framework of IT skills plus detailed training and development resources, providing organisations and practitioners the framework required for defining job profiles. Although introduced in 2003 following collaborative development, the SFIA framework is now in its 6th version (launched in July 2015) and has been revised to include cyber security skills more prominently.

The SFIA framework consists of six categories: Strategy and Architecture, Change and Transformation, Development and Implementation, Delivery and Operation,

[5] The SFIA website: www.sfia-online.org

Skills and Quality, Relationships and Engagement. Each of these categories is further divided into sub-categories, mapping out 97 separately identifiable skills.

Each skill is described at one or more of seven levels of responsibility, namely: Follow; Assist; Apply; Enable; Ensure and advise; Initiate and influence; and Set strategy, inspire and mobilise. Each of these responsibility levels also has a generic description detailing the level of autonomy, influence, complexity and business skills required. Skills apply at one or more of the seven levels – the higher the level, the more senior the practitioner. These items are summarised and depicted at an abstract level in Figure 5.1 below.

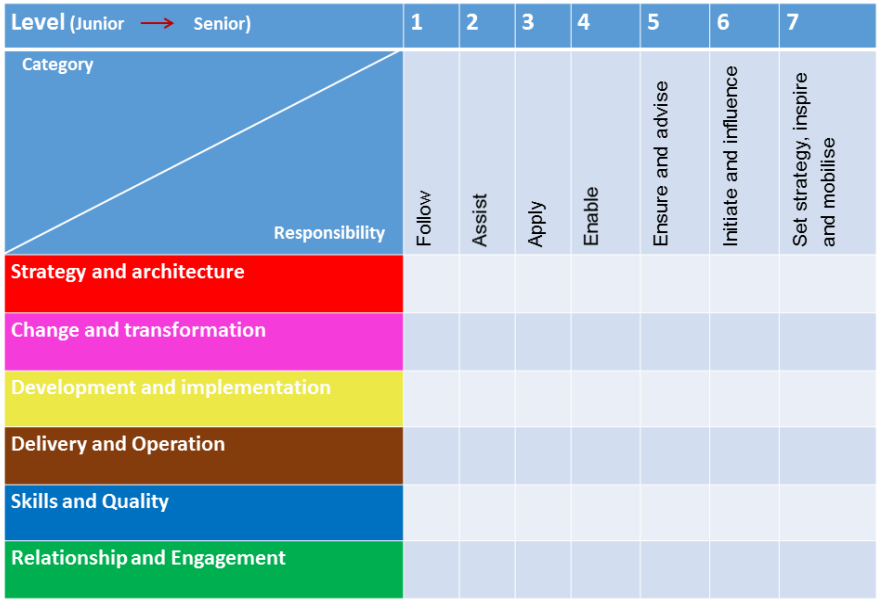


Figure 5.1 SFIA Framework (top-level)

The SFIA framework is seen to be a common language for individuals and organisations to define skills, abilities and expertise in a consistent way. It can help organisations in creating roadmaps, Human Resources planning, career development planning and configuring mixed teams. It can also help in workforce recruitment by being able to help create job profiles and descriptions.

Figure 5.2 gives an example of the skill Information Analysis with only Levels 3 and 7 definitions (for contrast) shown.

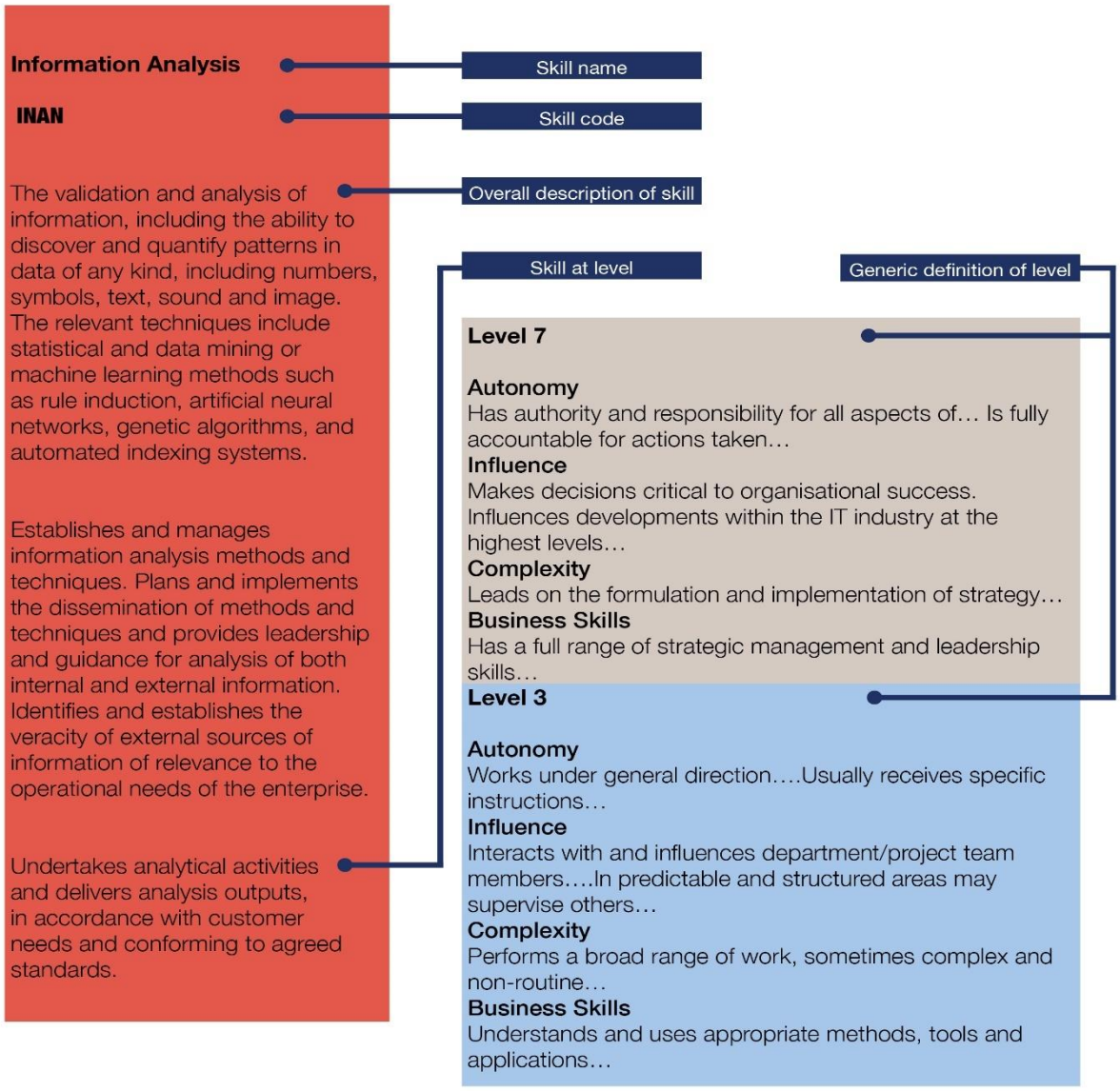


Figure 5.2 Adapted from SFIA 5 Framework Reference, SFIA Foundation

5.2.2 NICE

The National Cybersecurity Workforce Framework[6] is promoted and updated by the National Initiative for Cybersecurity Education (NICE) which falls under the umbrella of the US Department of Homeland Security. The NICE framework has similar goals to the SFIA framework – they both provide a common language with which employers, employees, recruiters, students and training providers are able to identify and standardise the required tasks and skills. However, whilst SFIA is for the IT professional, NICE is developed for the cybersecurity workforce.

The NICE framework organises cybersecurity work into 32 Speciality Areas and these are grouped into 7 categories based on similarity. For each Speciality Area, the framework presents a standard set of required tasks and knowledge, skills and abilities (KSAs). The 7 categories are Collect and Operate, Analyse, Protect and Defend, Operate and Maintain, Securely Provision, Investigate and finally Oversight and Development. An example of the 32 Speciality Areas is Digital Forensics which falls within the Investigate category. The framework then goes on to provide 55 KSAs for Digital Forensics, such as, knowledge of data carving tools and techniques (e.g. Foremost).

The NICE framework uses the term competency to mean the areas of expertise required for successful performance of a job function. This is not as fine-grained as usually expected, for example, in the case of the digital forensics Speciality Area, competencies listed include, amongst 18 others, Criminal Law and Cryptography.

5.2.3 IISP

The Institute of Information Security Professionals (IISP)[7] have developed a "skills framework to describe the range of competencies expected of Information Security and Information Assurance Professionals in the effective performance of their roles".

[6] The Framework can be utilised via an interactive website: https://niccs.us-cert.gov/training/tc/framework/

[7] The IISP website: www.iisp.org

It defines the skills and capability expected of security professionals in practical application and not simply an assessment of their knowledge.

The IISP framework defines 9 subject disciplines – each of which are further defined by a number of skills groups. For example, the subject discipline Information Security Management is defined by the groups: Governance, Policy and Standards and Information Security Strategy amongst others.

The IISP framework differs from the SFIA and NICE in that it includes a scoring mechanism based on a 4-level measurement, where Level 1 is Awareness, Level 2 is Basic Application, Level 3 is Skilful Application and Level 4 is Expert.

5.2.4 Discussion of Professional Frameworks

The three professional competency frameworks all share the particular common theme of systematically itemising, at varying degrees of detail, the entire breadth of skills and knowledge that a practicing professional is required to exhibit. However, this results in frameworks that are huge and unwieldy for the purposes of developing students within an academic programme. Although SFIA does include a levelling of expertise (from level 1 to 7) where an entry-level professional could be a new graduate and therefore deemed to be at level 1, the detail with which the skills are represented would make them unusable by a novice. In addition, it is clear that the frameworks adhere to their own specific terminology; for example, NICE KSAs can be interpreted as competencies in SFIA. This again means that the use of the framework for personal development can be a daunting prospect to a novice.

Professional frameworks have goals that are beyond just personal development – they enable an organisation to standardise skills for performance measurement, for reward schemes, for recruitment, for targeted training and for organisational efficiency and productivity. In addition, professional frameworks are very commonly aligned to industry certification and therefore fulfil an entirely different need.

For these reasons, there is a real need to adjust and arrive at a competency framework which can be readily utilised within an academic programme in the context of a work-related learning platform.

5.3 CFWRL: A Competency Framework for Work-related Learning

This section presents a competency framework designed to be used by and for students on a work-related learning module. The framework has two specific aims:

1. It must be usable by students for self-evaluation and self-regulation purposes.
2. It must allow for the support and dispensing of developmental feedback.

The framework has drawn from the NICE framework in terms of the separation of competencies into the associated sections: Personal Effectiveness competencies, Academic competencies and Workplace competencies. However, whereas NICE views these as tiers (that are presumably developed by individuals over time), in CFWRL we take the view that students on a work-related learning module develop their academic and workplace competencies in parallel and that furthermore, personal effectiveness competencies are developed in all areas of a student's environment. Within the NICE framework, an additional two tiers, namely 4 and 5 are related to industry-wide technical competencies and industry-sector functional areas respectively. Within CFWRL a general section labelled Job Role competencies is included as each work-related learning opportunity will differ from the next. Figure 5.3 depicts the four categories contained within CFWRL and the competencies included in each category. The competencies incorporated here are the most widely used across all the professional frameworks but have been assimilated and labelled in a customised way for optimum use by students and academic tutors. The findings from the initial Scoping study (Chapter 4) have also been assimilated here. The total number of competencies has been limited to twenty as anything more may an adverse effect on student engagement.

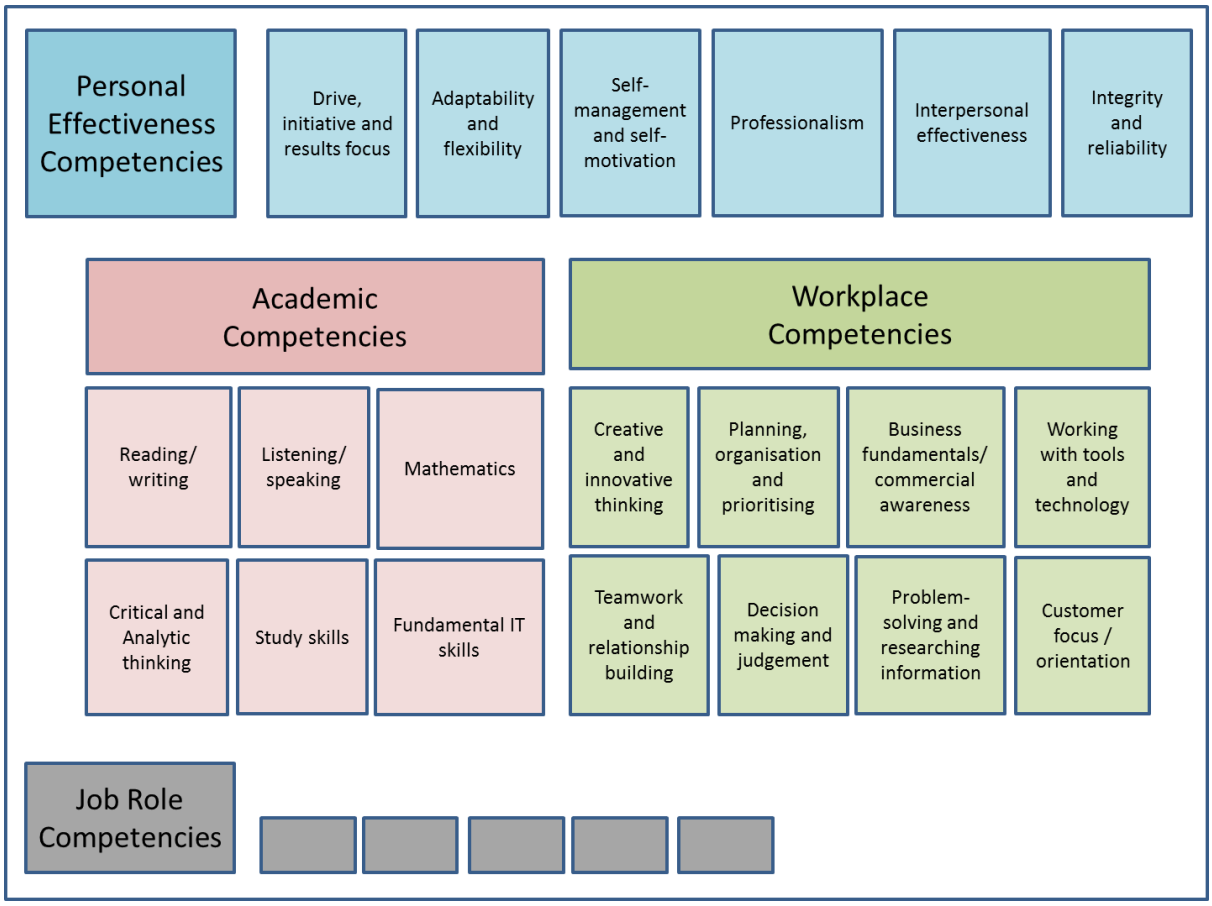


Figure 5.3 Competency Framework for Work-related Learning (CFWRL)

5.3.1 Employer Evaluation of CRWRL

Evaluation of the developed competency framework was performed prior to its use. Whilst ongoing judgement and comments were solicited from academic tutors during the development of the framework, on completion, external views were sought from industrial employers. A diverse range of industries, including financial services, law, investment, retail and data science were identified as an adequate breadth; and a set of employers were approached to evaluate the use of the competency framework within an academic programme. The evaluators' commentary was drawn out by a set of guiding questions, although not all of them provided their comments as specific responses to each and every question. All evaluators did however provide commentary on common practice within their

organisations of the use of competency measurement and thereby provided some insights into how these practices are managed in industry. In these terms, CRWRL can be deemed a useful tool for students to be exposed to. The evaluators were provided with a rating sheet containing all the competencies which would be used by individual students, along with some information about its intended use. The guiding questions were:

1. Is the competency list fit for purpose?
2. Are there any serious omissions?
3. Is there anything that should be taken out?
4. If the ratings were numbered from 1 to 7 (1=no skill and 7=highly competent) what sort of rating would make a graduate employable at entry level?
5. If a student scored themselves low then what affect would taking on the feedback give them?
6. Is the feedback appropriate?
7. How, in your opinion, should this feedback be administered to the student?
8. Can anything be added to this process?
9. How feasible is it to ask students to self-evaluate in an honest way?
10. Ultimately, do you think this is a good way to get a measure their WRL experience?

The evaluators' comments are summarised in Table 1. The predominant conclusion that can be derived is that CRWRL can potentially be a good exposure mechanism for students to begin to become accustomed to – as this is the type of performance measurement and appraisal that they will encounter when in employment.

Table 5.1 Employer Evaluation comments

Industry Role	Summary comments	Conclusion
Programme Manager, Financial Services UBS	• Self-evaluation of this type required 3 times a year for most staff. • Not entirely sure how WRL works but measuring of competencies/skills is done all the time – at selection, appraisal, promotion and re-hire.	Appears to be good practice for what happens regularly in this banking sector.
Technical Manager, Online retail company ASK Electronics	• Reduce the numbering to 5 (none, low, average, medium, high). • Incentivise somehow to drive students to participate.	The competency list is comprehensive and would be useful for those who really wish to improve.
Human Resource Executive, leading Law firm Clifford Chance	• Improvements section is good – regular team workshops are delivered around these. • Job requirements are based on competencies required for roles. • Additional competencies would be sought for Law, but in general an entry level role would be rated at 5 or above.	Competency measurement is standard practice and students/new graduates should be well-versed with it.
Data Science Consultant, Society of Data Miners	• Requires extensive support: discussion sessions to explain framework, help sessions during ratings process, several sessions for feedback/guidance. • Promote as personal development exercise NOT for assessment. • Frameworks can be subjective and therefore open to misuse.	Overall, the framework could be useful for self-learning, especially with extensive support.
Head of IT (Asia Pacific), global investment company Bernstein	• Similar (in part) to performance appraisal system. • Academic competencies are assumed – it is the other skills that are important in the workplace.	Useful exercise for students to prepare them – but they also require technical competencies.

5.4 Summary

We have developed a competency framework specifically for use by students on a Work-related learning module. Our framework, CFWRL, is an adapted and concise version of various professional competency frameworks. The main aim is for students to gain an early exposure to the appraisal and productivity measuring schemes utilised in industry. As graduates typically find it challenging to evidence and give examples of competency during the job interviewing process, a secondary aim is one of preparation for that exercise. The confidence-building opportunities that a concise framework used during a degree programme can have on students is also something that CFWRL is specifically aimed at.

6. Developmental Feedback and Self Skills

6.1 Introduction

The preliminary investigations have led to the development of the feedback taxonomy which highlights the need for a different form of feedback that is required for the Work-related Learning experience within an academic programme. In particular, the taxonomy affirms the significance of developmental feedback and self-management as important potential players in WRL initiatives. These players are discussed in this chapter against the backdrop of the competency framework developed in Chapter 5. Competencies can offer students an ideal opportunity to reflect on their perceived strengths and weaknesses in the context of employability and also to engage in a self-monitoring exercise.

6.2 Developmental Feedback

Developmental feedback is in common use within the organisational context where the popular format of 360-degree (or multi-rater) feedback, in which an individual employee is able to receive feedback from managers, executives, peers and direct or indirect reports, is used as a development exercise to promote self-direction. Whilst the 360-degree feedback model is used primarily for leaders or managers in the corporate environment to enhance personal effectiveness and growth, the developmental aspects of the model can be beneficial in other ways. For example, Joo et al. (2012) find the concept of developmental feedback, where it interacts with learning culture and team cohesion, to improve team creativity. Whilst Li et al. (2011) report positive improvements on new-comers task performance and individual proactive behaviour when receiving developmental feedback from supervisors and co-workers. Dargo-Severson and Blum-DeStefano (2014) use the term 'feedback for growth' for that differentiated feedback which education leaders can utilise. Taylor (2014) focuses on 360-degree or multisource feedback as a self-assessment tool with the 'self' at the heart of the exercise. Although the 360-degree feedback model is primarily an organisational tool, some of the developmental aspirations of the model may be suited for transposition into the academic arena

and educationalists have made some attempt to use it in an academic context. Tee and Ahmed (2014), for example, use the 360-degree feedback concept in the holistic sense of combining self, peer and teacher feedback. In general, however it is only the facet of developmental feedback where the individual concentrates on improving the competency of a contextualised task or behaviour of the 360-degree model that we focus on here, as it is this which students could most benefit from during a work-related learning experience.

Developmental feedback is very different from evaluative feedback as it looks forward to actions for improvement. Specifically, developmental feedback is not considered at the conclusion of an exercise, rather it is continual and formative. Developmental feedback can empower students because it can help them to identify weaknesses or gaps and can reinforce their role in enabling positive changes. Whilst the term developmental feedback has been chiefly confined to the corporate environment, the term feed forward has become significant in the initiatives deployed to engage students further with their learning.

Feed forward can be seen as being the reverse of feedback where a normal cause-effect relationship can be turned upside-down. A feed forward occurs when an understanding of the current deficiency is fed into an experience leading to improvement in the future. Educators have developed various interventions to aid the feed forward process; examples include the use of high impact written feedback from one assignment to the next (Vardi, 2013), a series of interventions which begin with engaging students with the criteria to be used for assessment (Walker and Hobson, 2014), several submissions of a report on a research-led module where students have access to their own and their peers feedback on draft submissions (Morrell, 2014), the use of video review to provide feed forward information on oral presentations (Murphy and Barry, 2016). Other examples, such as (Hughes, 2015) utilise the feed forward concept at a module-level in a more generic way to promote course level and subject-specific outcomes. (Fisher and Frey, 2009; 2011) discuss feed forward as a tool for teachers to analyse assessment data and make modifications to teaching and required learning.

(Chetwynd and Dobbyn, 2011) characterise feedback according to whether it relates to skills or content and whether it is retrospective or future-altering. They argue that "Students who receive, absorb and use future-altering comments should develop the academic skills for self-regulated learning". In this environment, future-altering feedback points forward explicitly to future work, stating and justifying the skills that are to be developed through the course of assessment.

With the presumption that developmental feedback should be a core element of self-development, we now consider the concepts of self-skills.

6.3 Self Skills

In this research, we give prominence to those skills which promote personal effectiveness in the workplace and beyond by coining the term 'self skills'. The word 'self' can precede a wide variety of verbs and nouns, as evidenced by Wiktionary[8] which currently lists more than 160 such terms (Appendix B). However, our focus is on the concepts which relate to students' enhancement of workplace skills such as self-development, self-management, self-motivation, self-awareness, self-presentation, self-evaluation, self-reflection and self-regulation.

A general premise of HE study is that students are able to build their self skills and so be able to self-evaluate, self-appraise, self-assess, self-reflect, self-manage and self-regulate. As many students find this challenging, the more opportunities for practice within their degree programme the better. Self-regulation together with peer or tutor feedback can assist in life-long learning and effectiveness in the workplace. Indeed, employers do seek individuals who have well developed self-management skills as they are likely to show better productivity. Also, individuals who display and practice better self-management skills are more likely to advance their careers and gain promotion. Self-management skills within the workplace cover the usual ones of communication, problem-solving and time management but can also include stress-resistance, memory and physical activity.

[8] www.wiktionary.org A collaboratively edited, multilingual and free web-based project

Approaches to engaging students in the practice of self skills development take many guises and range from, for example, a tool for learners to self-evaluate themselves in a 'self-directed' learning mode (Theunissen and Stubbe (2014)) to the use of a simple self-copying sheet for students to reflect on coursework feedback (Quinton and Smallbone (2010)). Whilst Hughes et al. (2014) use an ipsative feedback scheme for distance learners in which "..students completed a reflection on their progress in implementing past feedback".

Self-regulation and self-reflection are the skills that are focused on here, as it is these that students can practice and hone in the context of their work-related learning experiences. Self-regulation "results from students' self -generated thoughts and behaviours that are oriented systematically toward the attainment of their goals", (Zimmerman, 2008). Whilst self-reflection allows students to develop their critical thinking skills and so improve on future performance by cognitively analysing their experiences. Students who practice self-regulation and self-reflection are also able to improve their self-monitoring skills related to perceptions of progress, and in general improve their self-efficacy to continue to develop and improve.

Self-regulation and self-reflection are important skills for students as they need to determine what competencies have improved and what areas still require improvement. Students also need to monitor and control their own behaviour and emotions, adapting them to a given workplace situation. When these self-skills are employed, progress can be made transparent and opportunities for further discussion and development can be sought from tutors and/or employers.

In order for students to gain the most benefit with these self skills, they need a high degree of maturity and metacognitive ability.

6.4 Hattie and Temperly's Feedback Model

Hattie and Temperly (2007) define a feedback model aimed at reducing the "discrepancy between current understandings and performance and a goal" (p.86), which assumes that feedback operates at four levels: task, process, self-regulation

and self. This model of feedback surmises that effective feedback must be driven by answering three fundamental questions – namely Where am I going (Feed Up), How am I going (Feed Back) and Where to next? (Feed Forward). The two levels (of four) in this model to be considered here are the self-level and the self-regulation levels which the authors describe as 'self-monitoring, directing, regulating of actions and personal evaluations'.

An alternative – but parallel – way of looking at this is to consider the perspective that many HR and career development professionals have – the start/stop/continue questions. What should I start doing? What should I stop doing? What should I continue doing? For example, if a student wanted to improve their relationship building skills, a good first question would be, "What should I start doing that will enable me to improve my relationship building skills?" Some developmental feedback cues could be: "share your information with team members", "give and receive help from others", "look for ways to assist team members with heavy workloads and deadlines". The next question, "What should I stop doing to enable me to improve my relationship building skills?", the feedback cues may be: "stop always prioritising your own individual goals over team goals", "stop internalising problems but prepare to seek reassurance and help from team members". The final question, "What should I continue doing?", the feedback cues could be: "continue using positive body language and positive communication when engaging with others".

6.5 Making use of Developmental Feedback and Self Skills within the WRL context

Computing students on Work-related learning modules complete a portfolio-type assessment which is submitted at the end of the semester (or year). Assessment feedback practices identified in Chapters 2 and 3 can be utilised for this final summative assessment. However, there is obviously much opportunity for formative feedback which can be utilised for immediate improvement on the current task during the actual WRL experience. The developmental feedback and self-regulative opportunities for competency building within the duration of the actual WRL

experience are the focus here, rather than the feedback for assessment at the very end of the experience.

6.5.1 Developmental Feedback Cues

A complete set of guidance and instructions, in the form of cues and reminders, were designed for use with the Competency Framework built in Chapter 5. For each of the 20 competencies within the framework, separate developmental feedback cues were constructed. In this section, we firstly present a summary of the 20 competencies as shown in Figure 6.1, followed by the developmental feedback cues created for each competency as shown in Figures 6.2 to 6.21 (colourcoded from each of the categories of Workplace (green), Personal effectiveness (blue) and Academic(orange)). Care was taken to use terminology which students could understand and utilise for improvement whilst still reflecting professional terminology. Following the definition of the competency, some indications of how it can be evidenced are provided and also ways in which students can begin to think about improving the particular competency are suggested. The developmental cues are designed for use in feedback discussions with tutors/employers and also for use by individual students for further and continued self-regulation and self-reflection. Students varied greatly in the use they made of the developmental cues, with several students attending a feedback session having made some reflective notes (almost in the form of a diary) as a result of considering the competency suggestions.

Competency	Description
Teamwork and relationship building	Working collaboratively within a team and encouraging an environment of cooperation and commitment to achieve collective aims and deliverable goals.
Creative and innovative thinking	Collating and using information from multiple sources (including experiential and observational information) to explore options and identify and solve problems. Developing new ideas to address all kinds of workplace challenges.
Decision making and judgement	Making informed decisions that meet appropriate deadlines, always considering related facts, goals, constraints and risks.
Planning, organisation and prioritising	Managing tasks and problems with regard to their importance, to ensure projects can be completed and solutions can be found as efficiently as possible.
Business fundamentals and commercial awareness	Aligning the direction, services and products, and performance of an organisation in line with the rest of the business in a global context. Using knowledge of the business and extraneous factors (e.g. socio-political climate) to solve problems and complete tasks
Working with tools and technology	Applying technical knowledge and appropriate methodology to effectively tackle obstacles. Developing technical solutions to work through a range of new or complex problems.
Problem-solving and researching information .	Identifying, collating and organising information for analysis and decision-making, to help in resolving difficult or complicated tasks. Appropriately sourcing information that is useful, suitable, and accurate.
Customer focus/orientation	Establishing and maintaining customer satisfaction with the services and products the organisation offers.
Drive, initiative and results focus	Focusing on achieving results and desired outcomes. Getting the job done in spite of adversity. Showing determination and motivation to learn new skills or knowledge, even when mastering it is more difficult than you first expected.
Adaptability and flexibility	Being open to considering alternative ways to doing things. Being aware of the changes that are occurring in terms of business needs, conditions and responsibilities, and being prepared to adapt to meet the new expectations.
Self-management and self-motivation	Being aware of the impact your interactions with others can have. Planning and preparing your own time, resources and targets to complete tasks.
Professionalism	Taking personal accountability to meet or surpass workplace guidelines, standards and expectations, and to ensure the quality of your work remains consistent. Taking care to achieve results within given timelines and with little oversight.
Interpersonal effectiveness	Conducting yourself in such a way to establish strong relationships with a wide range of people. Encouraging and persuading others to help them achieve goals. Maintaining a strong sense of trust with others.
Integrity and reliability	Earning the trust and respect of others by consistently showing a strong work ethic, that centres around honesty and hard work. Taking pride in what you do in the work environment, and striving to achieve the best possible results.
Reading and Writing	Quickly grasping the meaning of written information and applying it to real-life situations. Conveying information and ideas in written form so that the reader will understand the key message.
Listening and speaking	Learning from what others say and interpreting the key messages in their words. Conveying ideas and facts orally, making sure the tone and language are matched to the situation.
Mathematics	Making use of mathematical techniques and tools to perform calculations, manipulate data and solve practical problems.
Critical and analytic thinking	Scrutinize data and information to draw justifiable conclusions, grasp certain ideas, and provide solutions.
Fundamental IT skills	Using information technology and related applications, hardware and software, to communicate and receive information.
Study skills	Understanding the use and application of a range of tools and techniques to help in your learning and training

Figure 6.1 A Summary of All Competencies

Workplace Competencies

Teamwork and relationship building

Working collaboratively within a team and encouraging an environment of cooperation and commitment to achieve collective aims and deliverable goals.

You show this competency by…

- ✓ Putting the goals and needs of the team ahead of individual ones
- ✓ Being aware of others' commitments and needs and responding willingly
- ✓ Contributing ideas and information to help the team and other team members meet their aims
- ✓ Designating or taking charge of clear roles and responsibilities within the team
- ✓ Following through on your obligations to the team, meeting individual deadlines and fulfilling individual aims
- ✓ Taking charge of a team
- ✓ Delegating effectively and driving others to meet their goals
- ✓ Encouraging others to contribute ideas and appropriately valuing their input

What you can do to improve…

- → Look for ways to assist team members with heavy workloads
- → Tactfully and diplomatically address issues within the team
- → Explore the use of tools which might aid in a virtual team environment
- → Seek help from others
- → Take shared responsibility for setbacks and accomplishments
- → Offer information to team members where it might be helpful
- → Be prepared to adopt both leader roles and follower roles
- → Be aware of other people's emotions
- → Learn to listen effectively

Figure 6.2 Workplace Competency 1

Workplace Competencies

Creative and innovative thinking

Collating and using information from multiple sources (including experiential and observational information) to explore options and identify and solve problems. Developing new ideas to address all kinds of workplace challenges.

You show this competency by…

- ✓ Adapting new information, knowledge and skills to address problems in creative or novel ways
- ✓ Ensuring such creative or unusual methods are workable and suitable solutions to difficult workplace problems
- ✓ Assessing situations to identify potential problems or opportunities
- ✓ Being willing to experiment with new procedures in the workplace to help in identify and solve problems
- ✓ Accessing, examining and utilising knowledge and skills attained from past experiences and from a range of disciplines
- ✓ Connecting apparently unrelated ideas and events, and applying the results in a global context

What you can do to improve…

- → Be flexible
- → Be prepared to take on new tasks
- → Try to come up with new solutions to difficult problems
- → Think outside the box
- → Develop your entrepreneurial skills
- → Break down problems by considering the human, interpersonal and technical aspects, and using these to formulate new and innovative proposals
- → Be an active participant in brainstorming sessions
- → Enhance your discussion- and debating-skills, so your proposal can be appreciated as far as possible

Figure 6.3 Workplace Competency 2

Workplace Competencies

Decision making and judgement

Making informed decisions that meet appropriate deadlines, always considering related facts, goals, constraints and risks.

You show this competency by…

- ✓ Identifying the pros and cons of all available options, and analysing the relative importance of each before coming to a decision
- ✓ Moving forward after coming to a conclusion, confident you made an informed and justifiably suitable decision
- ✓ Being able to explain the thought process that drove a certain decision
- ✓ Learning from the consequences of a decision you make, to better inform any future similar decisions

What you can do to improve…

- → Listen to others and take their input into consideration
- → Consider similar situations you have been in, and treat these as learning experiences to inform your decisions
- → Find a balance in your analysis between wisdom and experience
- → Where possible, avoid hasty decision-making; taking time to consider all perspectives can be more beneficial than coming to a conclusion faster
- → Stand by your decision, provided you feel it is an informed, reasonable and suitable one

Figure 6.4 Workplace Competency 3

Workplace Competencies

Planning, organisation and prioritising

Managing tasks and problems with regard to their importance, to ensure projects can be completed and solutions can be found as efficiently as possible.

You show this competency by…

- ✓ Identifying the sequence of tasks to be carried out, and the resources needed to achieve a goal, and prioritising key action steps
- ✓ Foreseeing potential obstacles and opportunities, and altering timelines as necessary
- ✓ Anticipating the potential risks and consequences of certain decisions
- ✓ Using the input of others to prioritize workloads, manage timelines, action sequences, and gauge potential and expected outcomes
- ✓ Being decisive when prioritizing multiple tasks
- ✓ Working with others to maximize output and meet deadlines

What you can do to improve…

- → Use timeline-specific tools to manage tasks: calendars, Gantt charts
- → Create realistic schedules for projects and stick to them
- → Evaluate your progress against your schedule and completed goals
- → Leave time to check your work thoroughly so that is not late
- → Follow instructions carefully and accurately: ask early on if unsure
- → Approach tasks with the appropriate methodology in mind
- → Develop a 'plan B' for even the smallest tasks
- → Keep track of documents, and keep all workspaces (real and virtual) uncluttered
- → Monitor all your work for errors: ask a co-worker to help you check

Figure 6.5 Workplace Competency 4

Workplace Competencies

Business fundamentals and commercial awareness

Aligning the direction, services and products, and performance of an organisation in line with the rest of the business in a global context. Using knowledge of the business and extraneous factors (e.g. socio-political climate) to solve problems and complete tasks.

You show this competency by…

- ✓ Establishing a functional relationship with clients, that clarifies their needs, and spotting opportunities to extend this relationship, or foster new ones
- ✓ Understanding how an organisation functions, and what factors, both external and internal, drive its business
- ✓ Expending the necessary time to understand your chosen industry at both the micro and macroscopic level
- ✓ Understanding why an organization's policies and practices exist

What you can do to improve…

- → Research the mission, structure and functions of your organisation
- → Stay up to date on what new strategies are implemented at the organisation
- → Explore the organisation's competitors, and identify ways to optimise the company's standing amongst them
- → Consider your own role in the company and what impact your actions and tasks have
- → Try to engage in and understand market trends and the organization's position in the industry on a global scale
- → Stay informed on organization-centric publications and all-staff emails

Figure 6.6 Workplace Competency 5

Workplace Competencies

Working with tools and technology

Applying technical knowledge and appropriate methodology to effectively tackle obstacles. Developing technical solutions to work through a range of new or complex problems.

You show this competency by…

- ✓ Evaluating, selecting and using hardware or software solutions that efficiently improve how you tackle a task
- ✓ Looking for opportunities to improve your knowledge of tools and technologies to increase productivity
- ✓ Being ready to adapt to technological changes or updates

What you can do to improve…

- → Ask for training when necessary
- → Consider using free time to take free online courses to improve technological proficiency
- → Participate in online forums to stay up to date on various hardware and software tools
- → Make sure you keep your knowledge in sync with the release of new updates of software and hardware

Figure 6.7 Workplace Competency 6

Workplace Competencies

Problem-solving and researching information

Identifying, collating and organising information for analysis and decision-making, to help in resolving difficult or complicated tasks. Appropriately sourcing information that is useful, suitable, and accurate.

You show this competency by…

- ✓ Breaking down problems into individual tasks to be completed, to locate any hidden or tricky aspects that would require more extensive solutions
- ✓ Identifying the root-causes of problems to tackle them head-on
- ✓ Being willing to offer a range of proposals, and understanding the pros, cons, risks and required resources associated with each one
- ✓ Knowing when more information is needed to find an appropriate solution; conversely, knowing when information is not suitable to the task at hand
- ✓ Spotting trends and relationships in data patterns and finding new areas for research
- ✓ Evaluating information to identify its usefulness for a particular problem

What you can do to improve…

- → Find trustworthy information sources, where you can find relevant, accurate data
- → Try to recall previously learned information that might be useful in the given task
- → Keep your research organised and accessible

Figure 6.8 Workplace Competency 7

Workplace Competencies

Customer focus/orientation

Establishing and maintaining customer satisfaction with the services and products the organisation offers.

You show this competency by…

- ✓ Understanding the needs and limits of the client
- ✓ Looking to find out more about customers to offer a better service
- ✓ Engaging in and responding to customer needs or complaints promptly
- ✓ Extending the service beyond basic expectations to help clients implement complete and satisfactory solutions
- ✓ Being prepared with alternative options when unable to deliver on a requested service
- ✓ Asking for customer feedback and using it to inform future interactions with clients
- ✓ Being willing to critically assess the organisation and its services and products from the point of view of the customer
- ✓ Politely dealing with hostile clients

What you can do to improve…

- → Always remain pleasant, polite and professional when dealing with internal and external clients
- → Establish ways of measuring, recording and tracking customer satisfaction
- → Ensure you always listen to what the customer is actually asking for, and be prepared to deliver creative, unusual or novel solutions

Figure 6.9 Workplace Competency 8

Personal Effectiveness Competencies

Drive, initiative and results focus

Focusing on achieving results and desired outcomes. Getting the job done in spite of adversity. Showing determination and motivation to learn new skills or knowledge, even when mastering it is more difficult than you first expected.

You show this competency by…

- ✓ Setting ambitious but achievable goals, and working hard to reach them
- ✓ Pushing yourself and inspiring others to reach milestones
- ✓ Always being on the lookout for opportunities to advance the project
- ✓ Responding to setbacks with a positive resilience
- ✓ Being persistent in particularly difficult circumstances
- ✓ Willingly putting in time and effort in crisis situations
- ✓ Spotting when discussion, analysis and selection of data or information has served its purpose, and taking the initiative in progressing with a plan of action

What you can do to improve…

- → Set achievable targets for a range of timescales (eg. daily, weekly, monthly, quarterly goals) that challenge you to increase productivity at all times
- → Develop clear goals for meetings and projects
- → Establish a pattern of measuring your performance against a set of target criteria
- → Keep a sense of urgency, but also positivity, about getting things done
- → Be independent in taking action where necessary
- → If you spot a task that needs to be done, but see that it is unallocated, do not wait to be asked to follow through on it
- → Don't be disheartened by setbacks, but treat them as ways to learn and continue to progress on the project
- → Always look to go above and beyond the scope of the task at hand

Figure 6.10 Personal Effectiveness Competency 1

Personal Effectiveness Competencies

Adaptability and flexibility

Being open to considering alternative ways to doing things. Being aware of the changes that are occurring in terms of business needs, conditions and responsibilities, and being prepared to adapt to meet the new expectations.

You show this competency by…

- ✓ Responding to changes with a positive attitude
- ✓ Adapting to new circumstances quickly
- ✓ Dealing with a diverse range of tasks, managing them all equally
- ✓ Being willing to apply past experiential knowledge to new situations
- ✓ Embracing the new policies and practices that accompany changes within the organization, and use these to continue to accomplish tasks and provide solutions
- ✓ Recovering quickly from setbacks, and looking for new ways to reach goals and meet targets
- ✓ Ensuring new priorities are made clear when leading change
- ✓ Ensuring change in the organization does not worry others

What you can do to improve…

- → Be open to alternative or new structural, procedural and technological changes
- → Be willing to adopt a new strategy if an initially selected one proves unsuccessful
- → Be prepared to let go of a strongly held position when presented with contrary evidence
- → Understand the merits of the perspectives of others

Figure 6.11 Personal Effectiveness Competency 2

Personal Effectiveness Competencies

Self-management and self-motivation

Being aware of the impact your interactions with others can have. Planning and preparing your own time, resources and targets to complete tasks.

You show this competency by…

- ✓ Being willing to accept responsibility for successes and failures alike
- ✓ Staying aware and showing an understanding of yourself as a learner
- ✓ Developing a strong sense of personal accountability
- ✓ Being proactive about your own learning and development
- ✓ Recognizing your strengths and weaknesses, and working to improve these
- ✓ Managing and adjusting priorities as appropriate
- ✓ Devoting time and effort to critical tasks to achieve goals
- ✓ Being able to transition between tasks efficiently

What you can do to improve…

- → Be prepared to give every task 100%, and ask for training when needed
- → Take a fair share of the workload, the responsibilities, and the rewards
- → Evaluate your progress regularly and plan for how to continue achieving goals
- → Demonstrate a strong understanding of all the relevant facts and information
- → Be honest with others, and respect the confidentiality of their sensitive information

Figure 6.12 Personal Effectiveness Competency 3

Personal Effectiveness Competencies

Professionalism

Taking personal accountability to meet or surpass workplace guidelines, standards and expectations, and to ensure the quality of your work remains consistent. Taking care to achieve results within given timelines and with little oversight.

You show this competency by…

- ✓ Taking the time to understand and adapt to workplace environments
- ✓ Always being on time, and meeting standards for dress and conduct
- ✓ Following instructions, policies and procedures, and fulfilling the standards, deadlines and schedules expected for your work
- ✓ Minimising the impact distractions or interruptions have on your work
- ✓ Not making excuses; accepting mistakes and doing your utmost to correct them quickly
- ✓ Optimizing the available time and resources to achieve goals
- ✓ Addressing problems with others quickly and directly, and recognizing the rights and responsibilities of yourself and others

What you can do to improve…

- → Pay attention to the cultural norms
- → Keep your emotions in check, and deal with stressful situations calmly
- → Take pride in your own work
- → Take pride in how you project yourself to others in the organisation, in the way you dress and conduct yourself
- → Think about ways in which your actions and speech can reflect commitment and optimism
- → Do not publicly disparage the company or its employees
- → Treat confidential information with care
- → Always be polite, even if you do not like someone

Figure 6.13 Personal Effectiveness Competency 4

Personal Effectiveness Competencies

Interpersonal effectiveness

Conducting yourself in such a way to establish strong relationships with a wide range of people. Encouraging and persuading others to help them achieve goals. Maintaining a strong sense of trust with others.

You show this competency by…

- ✓ Working with others effectively, regardless of their background
- ✓ Showing sensitivity and insight into others' situations
- ✓ Treating people with empathy and trust
- ✓ Showing a willingness to adapt and be flexible in response to the actions and ideas of others
- ✓ Working to resolve conflicts and negotiating well with others
- ✓ Being known amongst your peers as someone they can rely on

What you can do to improve…

- → Look for ways to assist others
- → Sincerely show an interest in others and their concerns
- → Encourage others to share their problems with you, and treat them fairly
- → Do not initiate conflict, but work to resolve it
- → Thank others for their assistance
- → Try to remain friendly, cheerful and polite all the time

Figure 6.14 Personal Effectiveness Competency 5

Personal Effectiveness Competencies

Integrity and reliability

Earning the trust and respect of others by consistently showing a strong work ethic, that centres around honesty and hard work. Taking pride in what you do in the work environment, and striving to achieve the best possible results.

You show this competency by…

- ✓ Giving information in a clear, accessible way, and encouraging others to do the same
- ✓ Behaving with discretion about what you know or do not know
- ✓ Keeping promises and fulfilling commitments
- ✓ Striving to do the right thing, even when it is the more difficult option
- ✓ Avoiding problematic or inappropriate situations
- ✓ Generating ideas to improve your work ethic
- ✓ Monitoring the quality of your work
- ✓ Taking personal accountability for the consequences of your decisions

What you can do to improve…

- → Be on time for all deadlines, meetings and work days
- → Thoroughly check your work for errors or inconsistencies, and correct them
- → Always be honest in all your dealings with others
- → Understand the core values of the organization, and use these to influence your work – these can be found in the strategic plan or mission statement
- → Evaluate your work for effectiveness, and check it for errors

Figure 6.15 Personal Effectiveness Competency 6

Academic Competencies

Reading and Writing

Quickly grasping the meaning of written information and applying it to real-life situations. Conveying information and ideas in written form so that the reader will understand the key message.

You show this competency by…

- ✓ Conveying ideas and information clearly, succinctly and accurately
- ✓ Using language, style and writing methods appropriate to a range of situations
- ✓ Anticipating what information others might need and delivering it to them
- ✓ Understanding the use of graphs/charts and other visual aids to written information
- ✓ Adhering to rules and policies concerning written communication, and using communication tools courteously

What you can do to improve…

- → Consider the format, tone and style of all written correspondences you produce
- → Thoroughly check written communication for accuracy
- → Examine other pieces of communication, specifically looking for bias, differentiating between fact and opinion, and understanding the writer's purpose, to inform how you form your own correspondences
- → Always use correct grammar
- → Consider ways to diversify how you represent information to better communicate your key ideas
- → Practice summarizing articles so that you can keep your own correspondences succinct and always on-topic
- → Ask others to proofread your work/ask to proofread their work

Figure 6.16 Academic Competency 1

Academic Competencies

Listening and speaking

Learning from what others say and interpreting the key messages in their words. Conveying ideas and facts orally, making sure the tone and language are matched to the situation.

You show this competency by…

- ✓ Using specific language, tone, body language and pauses to increase the impact of what you say
- ✓ Diversifying your content, style and tone to address the subject and purpose of your words, and the various needs of a diverse audience
- ✓ Capturing the attention of the audience
- ✓ Giving your undivided attention to the speaker, and actively listening to what they have to say
- ✓ Allowing others to say what they have to say uninterrupted
- ✓ Reading the body language of others and responding appropriately
- ✓ Realizing that spoken information is not as easily interpreted as written information, and so simplifying complex ideas while retaining the key message

What you can do to improve…

- → Practice your phone skills at home
- → Ask questions to clarify your work tasks
- → Use your discretion as to what to say and when to say it
- → Never use slang or offensive language in the workplace
- → Maintain eye contact, and consider your body language when talking with others
- → Remember that active listening is not the same as hearing

Figure 6.17 Academic Competency 2

Academic Competencies

Mathematics

Making use of mathematical techniques and tools to perform calculations, manipulate data and solve practical problems.

You show this competency by…

- ✓ Performing basic arithmetic (addition/subtraction, multiplication/division) and using basic numeral concepts (eg. percentages, rounding) to carry out tasks
- ✓ Making reasonable guesses at arithmetic solutions without using a calculator
- ✓ Using standard tools and equations to take measurements of weight, length, area and volume
- ✓ Applying algebraic and statistical techniques to manipulate data
- ✓ Understanding, identifying and applying the appropriate algebraic, statistical and arithmetic procedures and tools to complete a task
- ✓ Creating ways to measure and analyze data

What you can do to improve…

- → Practice spreadsheet skills regularly
- → Keep up to date on new mathematical technological aids and software
- → Keep basic arithmetic skills up to standard by using leisure time to play brain-teaser games
- → Practice taking measurements of physical dimensions and quantities (e.g. weight, length, area, volume) and manipulating these measurements with appropriate formulae to derive other quantities

Figure 6.18 Academic Competency 3

Academic Competencies

Critical and analytic thinking

Scrutinize data and information to draw justifiable conclusions, grasp certain ideas, and provide solutions.

You show this competency by…

- ✓ Disassembling the components of a larger idea and using them to better understand the concept, ultimately to produce improved performance
- ✓ Making use of inductive and deductive reasoning, and drawing justifiable inferences and conclusions
- ✓ Knowing the right questions that need to be asked
- ✓ Identifying key data in a large amount of information, and spotting when information is not useful to the situation
- ✓ Identifying relationships between data patterns, and drawing conclusions from the similarities or differences
- ✓ Applying conclusions drawn from on set of information to a new set of data to create new insights or levels of understanding
- ✓ Picturing generalized models from conclusions drawn from concrete data sets

What you can do to improve…

- → Approach complex problems by breaking them down into smaller, more achievable tasks
- → Remember to weigh the risks, benefits and cons to a decision
- → Understand that problems often have more than one cause and look to address each one
- → Identify relationships between similar problems
- → Look for underlying patterns or principles in pieces of information
- → Try to get to grips with new information quickly

Figure 6.19 Academic Competency 4

Academic Competencies

Fundamental IT skills

Using information technology and related applications, hardware and software, to communicate and receive information.

You show this competency by…

- ✓ Understanding the basic operation and terminology of computer hardware, software, information systems and communication devices
- ✓ Using word processing software to create, edit and print documents and communications
- ✓ Using spreadsheet software to enter, edit, manipulate, represent and configure text and data
- ✓ Using presentation software to create, edit and present information to an audience
- ✓ Using database software to access and manage data
- ✓ Using graphics software to create and manipulate images

What you can do to improve…

- → Use emails to communicate quickly and efficiently with others
- → Use and maintain a way to keep your files well organised electronically
- → Use Internet-based solutions for workplace tasks (e.g. calendar and contact management)
- → Understand the different uses of social media, and know which are suitable for use in the workplace and which are not
- → Be fluent in the use of your organization's collaborative or "groupware" software solutions to make working as a team more effective
- → Read, understand and adhere to your organization's privacy policy and information security guidelines
- → Keep your applications up to date as far as possible
- → Use strong passwords and basic levels of encryption
- → Keep multiple backups for all important files

Figure 6.20 Academic Competency 5

Academic Competencies

Study skills

Understanding the use and application of a range of tools and techniques to help in your learning and training

You show this competency by…

- ✓ Keeping yourself organised to maximise efficiency
- ✓ Prioritizing important tasks quickly and sticking to your decisions
- ✓ Practicing assignment writing skills, and sticking to assignment deadlines and criteria
- ✓ Understanding instructions and requirements
- ✓ Making use of library facilities, as well as personal information tools
- ✓ Examining Internet research critically to decide if the information is reliable
- ✓ Understanding referencing systems and never plagiarizing
- ✓ Reflecting on marked work and on written or oral notes given by an instructor
- ✓ Making the most of instructors and peers as opportunities to learn
- ✓ Developing assessment skills – performing under the pressure of examinations
- ✓ Developing strong critical reading, revision and writing skills

What you can do to improve…

- → Use a diary or digital calendar to organise your time into work, study and personal time
- → When making notes, ensure they are legible, memorable and succinct, while retaining the important information at all times
- → Use a variety of tools for revision purposes – e.g. colour-coding notes, using recorded soundbites, producing mind-maps
- → Complete assignments on time and to a standard of work that you are satisfied with
- → Maintain a daily and weekly schedule, and stick to it to ensure all tasks are completed on time

Figure 6.21 Academic Competency 6

The developmental feedback content was made available via a simple but accessible interactive web tool, screens from which are depicted in Figure 6.22a and Figure 6.22b. The intention here is only to give a flavour of how individual students could make use of the tool independently and regularly throughout their WRL experience which typically lasts 8-10 weeks but can be much longer. During preliminary discussions, it was apparent that students would find it challenging to assimilate the content for all 20 competencies at once. Therefore, the web tool gives some flexibility as to which portions of the content they wish to access.

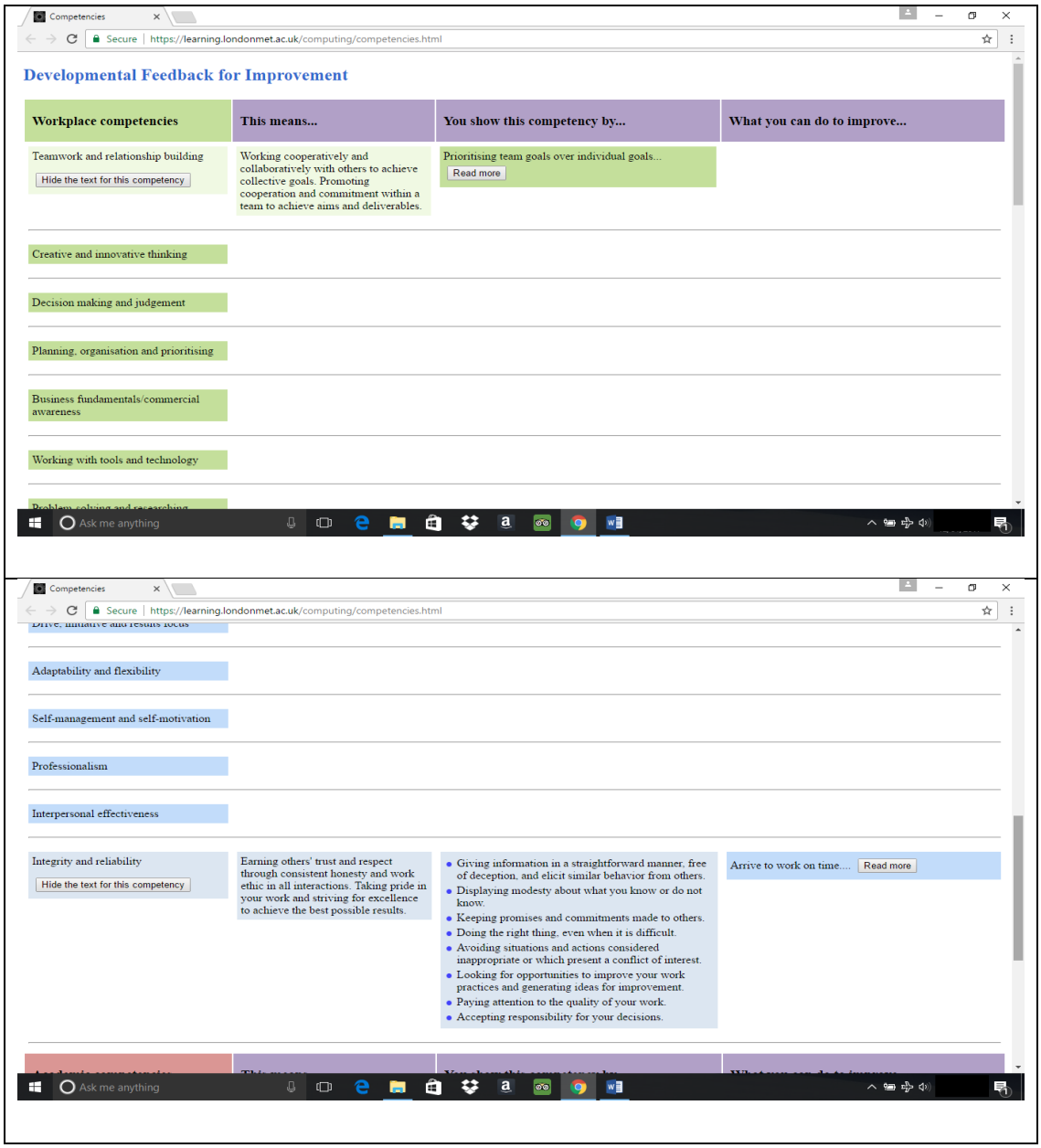


Figure 6.22a A Set of Sample Competency Tool Screenshots

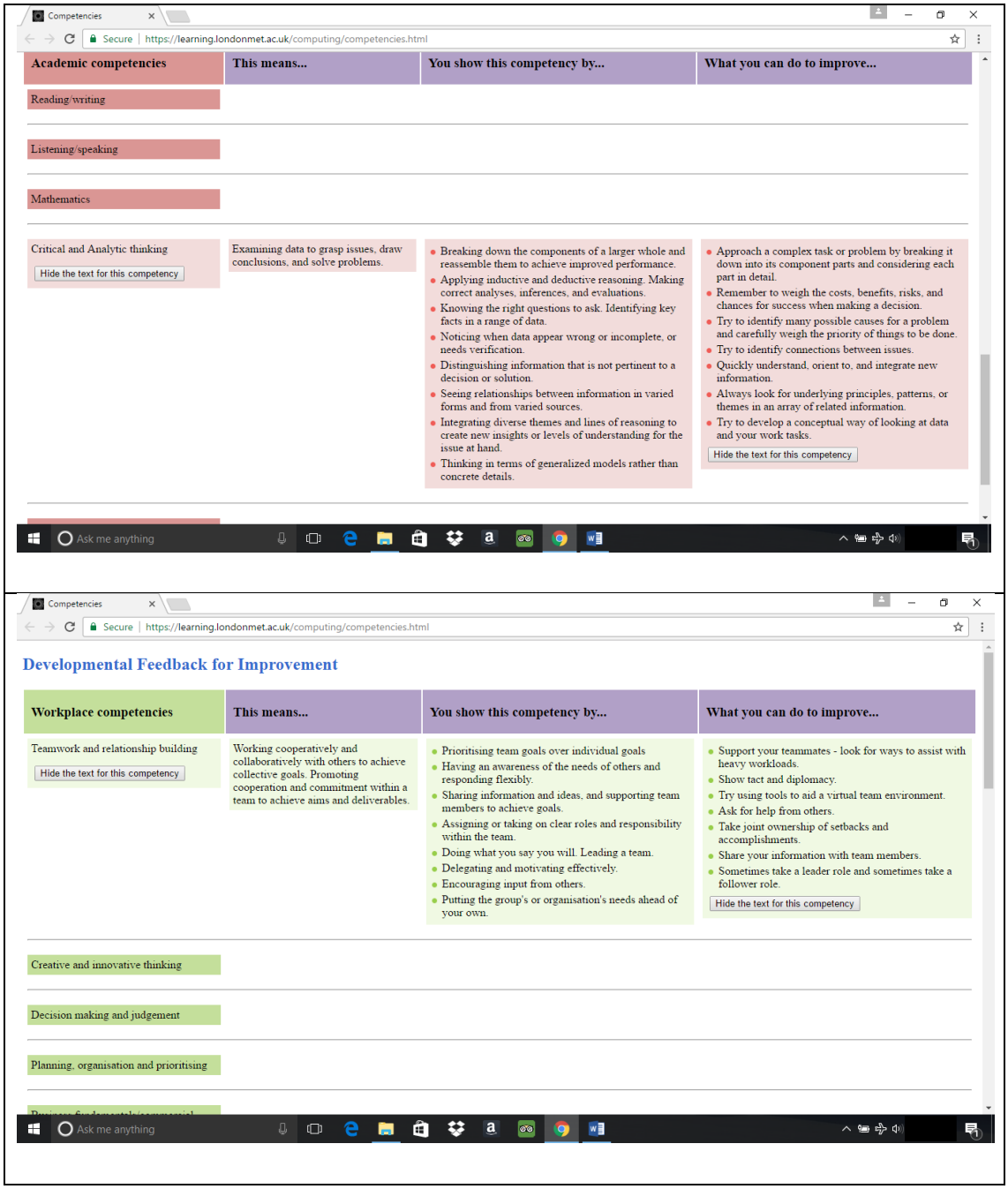


Figure 6.22b A Set of Sample Competency Tool Screenshots

Developmental feedback sessions were shaped around Hattie and Temperly's three fundamental questions where possible. Typically, only two or three competencies were dealt with in a given session. In fact, many students found the entire range of 20 competencies too much to deal with together. The most fruitful discussions were those where students had come prepared with some reflections. In general, students did not wish to discuss academic competencies very often and perhaps these are best dealt with in their taught modules. Feedback sessions would vary from student to student – as the actual work task would differ and also each student's cognitive and behavioural capacity for assimilating and utilising the feedback would differ. The tutor's role is primarily as facilitator to encourage self-skill practice and bring a progressive and incremental perspective to the students' self-development. This activity is, by its nature, time-consuming, but ultimately worth the effort of enabling opportunities for students to self-develop.

The results and some insights into students' perceptions regarding these developmental feedback sessions are given in Chapter 7 where qualitative analysis of the research is detailed.

6.5.2 Self-evaluation Form

Our aim now is to utilise the CFWRL framework and the associated developmental feedback cues by requiring students to make use of them in a self-evaluative manner under the guidance of a tutor. To this end, we created a competency form, Figure 6.23, to allow students to self-rate themselves on each of the 20 competencies. The manner in which this form was deployed is detailed in the next chapter, but essentially students completed this form at the commencement and at the conclusion of their WRL experience. The ratings themselves were the subject of developmental feedback sessions and formed the basis on which students explored the corresponding feedback for those competencies that needed improvement.

Module:	Your name:
Skill	Please circle for each competency:
	No skill <---1---2---3---4---5---6---7---> Highly skilled
Workplace competencies	
Teamwork and relationship building	<---1 2 3 4 5 6 7--->
Creative and innovative thinking	<---1 2 3 4 5 6 7--->
Decision making and judgement	<---1 2 3 4 5 6 7--->
Planning, organisation and prioritising	<---1 2 3 4 5 6 7--->
Business fundamentals/commercial awareness	<---1 2 3 4 5 6 7--->
Working with tools and technology	<---1 2 3 4 5 6 7--->
Problem-solving and researching information	<---1 2 3 4 5 6 7--->
Customer focus / orientation	<---1 2 3 4 5 6 7--->
Personal effectiveness competencies	
Drive, initiative and results focus	<---1 2 3 4 5 6 7--->
Adaptability and flexibility	<---1 2 3 4 5 6 7--->
Self-management and self-motivation	<---1 2 3 4 5 6 7--->
Professionalism	<---1 2 3 4 5 6 7--->
Interpersonal effectiveness	<---1 2 3 4 5 6 7--->
Integrity and reliability	<---1 2 3 4 5 6 7--->
Academic competencies	
Reading/writing	<---1 2 3 4 5 6 7--->
Listening/speaking	<---1 2 3 4 5 6 7--->
Mathematics	<---1 2 3 4 5 6 7--->
Critical and Analytic thinking	<---1 2 3 4 5 6 7--->
Fundamental IT skills	<---1 2 3 4 5 6 7--->
Study skills	<---1 2 3 4 5 6 7--->

Figure 6.23 Student Competency Self-rating Form

In order to summarise the various parts of the intervention described, Figure 6.24 highlights the iterative activity of exploring developmental feedback for a particular competency and then either seeking a discussion session and/or self-reflecting and self-regulating.

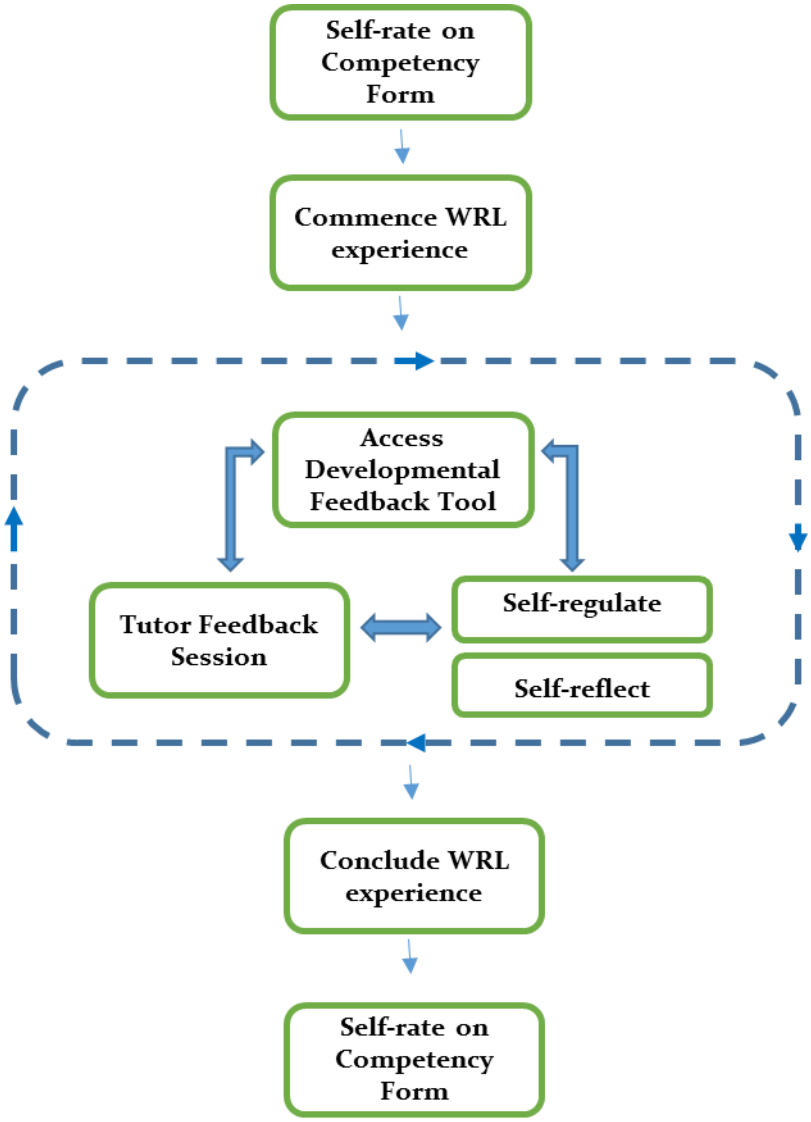


Figure 6.24 Students' Competency-building Journey

6.6 Summary

Students' self and professional development can be supported with pedagogically designed interventions which are integrated with experiential learning during a Work-related learning experience. Challenging students to self-reflect on a generic set of competencies which are required to be applied to workplace tasks can be an effective endeavour with long lasting benefit. Self-evaluation by students also benefits tutors by indicating the areas and skills that students tend to be less certain of and identifies those students who are either under or over confident. Opportunities to provide feedback at multiple stages of the WRL experience can help to rejuvenate students' motivation and effort, thereby enabling the practice of self skills.

7. Deployment of Proposed Tools and Statistical Analysis

7.1 Research Philosophy and Approach

The competency framework and developmental feedback developed in the previous chapters can now be utilised as the basis for the study of a group of Computing students. The research design uses a cross-sectional survey methodology which allows students to self-evaluate themselves on the 20 competencies included in the framework. The purpose of the design is to correlate the scores of the self-evaluation before and after the work-related learning experience as well as measure the interrelationship of the responses.

7.2 Research Method

A mixed methodology involving both quantitative and qualitative investigation was deemed appropriate to gain a broader perspective. A mixed method approach encompasses the principles of complementarity and triangulation and is therefore able to provide stronger evidence for arriving at conclusions. Mixed methodology research can also offer further insights and understanding than a single method, as well as more data for future discussions and research. However rather than using the qualitative investigation for initial observation, we gathered qualitative perceptions from students during the Work-related learning (WRL) experience in order to substantiate the quantitative results. The overarching working hypothesis is that improvements in student perceptions of their WRL experiences would be evident and measurable.

7.2.1 Sampling

A purposive sampling of participants was used to include students following a Computing degree in which the majority of the sample had undertaken a work-related learning (WRL) module. 102 such students were initially identified with another 30 students constituting a control group. The WRL students were either in their 2nd year (of a two-year foundation degree) or 3rd year (of an honours degree)

Computing-related programme and were enrolled on either a single semester or year-long WRL module.

As a variety of statistical methods for testing the significance of developmental feedback and Work-related learning experience are to be used, and the effect is predicted to be medium, a power analysis (Table 7.1) as included in a popular research guide[9] is reproduced here as it suffices for the current situation.

Table 7.1 Power Analysis for *t* test

Effect size	N per group	Total N
Large	393	786
Medium	64	128
Small	26	52

Therefore, when using the normal levels of significance (0.05) and power (0.8), we would require a total of 128 students in order to achieve a medium effect prediction.

This means that a satisfactory number of participants were included in the sample for the power required. Appendix C gives details of additional consideration of validating the sample size by power calculation, from which we can conclude that our sample size of 132 is adequate.

The recruitment of students onto the study was determined by restricting the sample to Computing-related degree courses in the academic year 2015-16. All students who were enrolled on a Work-related learning (or close equivalent) module were included in the sample and all such students had to complete the self-evaluative survey as part of the portfolio of assessment. The control group was selected as being made up of those students who were on a Computing-related

[9] Rudestam, K. E. & Newton, R. R., Surviving your dissertation: A comprehensive guide to content and process, 2015

degree course with no provision for Work-related learning in the form of an embedded module.

7.2.2 Research Ethics

The three core principles found in the Belmont Report[10], namely Respect, Beneficence and Justice are adhered to in this study. These core principles are understood and practiced by the researcher in a wider educationalist context as a trained educator for almost three decades. Respect for students was highlighted in all individual and group discussions where students were told exactly what use would be made of the self-evaluation forms. Confidentiality was maintained as these forms, and indeed any part of individual conversations, were not shared amongst the students. All students were made aware of the benefit to themselves of participating in the study and the accruing of this benefit to their development in the workplace and to their practice of self-evaluation. Although students were given the choice to opt out of participation to the developmental feedback sessions, all students chosen in this category did participate. Students were made aware that the risk of exposing themselves in discussions would be mitigated by the multiple benefits to be gained from the developmental exercise. Justice was ensured by making students aware that the disclosure of any discussions (or part of) would remain anonymous. The students also appreciated that the findings of the study could be used to improve curriculum design in order to benefit future students.

Informed consent was gained during a set of introductory (by module) presentations in which the purpose, implications, timescales and outcomes were presented to the students.

[10] National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. The Belmont Report. Ethical Principles and Guidelines for the Protection of Human Subjects of Research. Washington, DC: National Institutes of Health, 1979. Available: http://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/

7.2.3 Research Instruments (Data Collection)

The universally employed Likert Scale was used to measure the level of skill as perceived by individual students for the 20 competencies in the model. The decision to use a 7-point scale was taken as competence is seldom a straightforward question of 'can or cannot'; rather it is useful to allow a student to evaluate each competency at a broader range of skill level. The advantage of simplicity of use was deemed to outweigh the disadvantage of individuals' avoidance of choosing at the extremes of the scale. Figure 7.1 gives the self-evaluative survey which was administered to all students at the beginning and also at the end of their WRL experience. The control group, who did not take the WRL module, were also treated in the same way in that they were asked to complete the survey at the beginning and end of the semester. Students were required to provide a rating of their chosen skill level from 1 (no skill) to 7 (highly skilled).

A pilot test was conducted with a handful of students which helped to clarify the formatting requirements further. In particular, the two extremes of the scales, i.e. 'no skill' and 'highly skilled' were swapped and some colour coding was added to visually differentiate the list of competencies, leading to Figure 7.1.

It is acknowledged that the validity of the Likert scale can be compromised due to the desire on the individual's part to be seen in a positive light. Added to this is the challenge that the survey could not be anonymised as the same individuals needed to be tracked both before and after. Responses to self-administered questionnaires can by their nature be biased. However, in this case students were coached in the non-assessed developmental benefits of responding as honestly as possible.

Module:	Your name:
Skill	Please circle for each competency:
	No skill <---1---2---3---4---5---6---7---> Highly skilled
Workplace competencies	
Teamwork and relationship building	<---1 2 3 4 5 6 7--->
Creative and innovative thinking	<---1 2 3 4 5 6 7--->
Decision making and judgement	<---1 2 3 4 5 6 7--->
Planning, organisation and prioritising	<---1 2 3 4 5 6 7--->
Business fundamentals/commercial awareness	<---1 2 3 4 5 6 7--->
Working with tools and technology	<---1 2 3 4 5 6 7--->
Problem-solving and researching information	<---1 2 3 4 5 6 7--->
Customer focus / orientation	<---1 2 3 4 5 6 7--->
Personal effectiveness competencies	
Drive, initiative and results focus	<---1 2 3 4 5 6 7--->
Adaptability and flexibility	<---1 2 3 4 5 6 7--->
Self-management and self-motivation	<---1 2 3 4 5 6 7--->
Professionalism	<---1 2 3 4 5 6 7--->
Interpersonal effectiveness	<---1 2 3 4 5 6 7--->
Integrity and reliability	<---1 2 3 4 5 6 7--->
Academic competencies	
Reading/writing	<---1 2 3 4 5 6 7--->
Listening/speaking	<---1 2 3 4 5 6 7--->
Mathematics	<---1 2 3 4 5 6 7--->
Critical and Analytic thinking	<---1 2 3 4 5 6 7--->
Fundamental IT skills	<---1 2 3 4 5 6 7--->
Study skills	<---1 2 3 4 5 6 7--->

Figure 7.1 Student Competency Self-rating Form

7.2.4 Procedure for data and information gathering

All students were asked to respond to the survey at approximately the same time prior to the start of the bulk of their WRL experience. Students were requested to include their names on the response and to answer as honestly as possible. An online survey facility was not used as each individual had to be identified. The sample was then randomly divided into two, with one half of the group to be given developmental feedback during the course of 10-12 weeks. Wherever possible the feedback was given face-to-face, but on occasion these sessions were conducted by

telephone or video-chat. An interactive webpage was created to allow students to focus on particular competencies at a time. The feedback sessions were based around the use of this webpage as well as discussions on competence improvement for current tasks.

Qualitative data was gathered during the feedback sessions and recorded as notes for each student who received feedback. At the end of the WRL module, a small focus group, with a phenomenological approach, was undertaken to study the subjective experiences of students. The focus group comprised of two students from each of the categories:

- WRL module and developmental feedback
- WRL module but no developmental feedback
- No WRL module and developmental feedback
- No WRL module but no developmental feedback.

7.3 Quantitative Analysis

Usable data was collated from 97 WRL students and 28 non-WRL students (7 students from the initial sample were discarded as 2 students withdrew from their programmes and 5 students only completed the 'before' rating). The primary hypothesis is that there will be a significant difference between those receiving feedback and those who did not. However, a number of questions and aspects need to be also investigated, such as:

How effective is the developmental feedback?

How effective is the WRL experience?

Are there any gender differences?

Are Foundation degree students more likely to benefit from feedback than Honours degree students?

Is there any inter-relationship amongst the individual competencies?

Are there any particular competencies where students have improved significantly?

7.3.1 Descriptive Statistics of Student Sample

A series of tests were performed to establish some insight into these aspects, the results of which appear in the next sections. Firstly, we consider some demographic characteristics of the student sample.

Figure 7.2 shows that just over 50% of the sample population are aged between 22-24 years. Figure 7.3 illustrates the characteristics regarding gender, type of degree and year of degree (level 5 is 2nd year and level 6 is 3rd year).

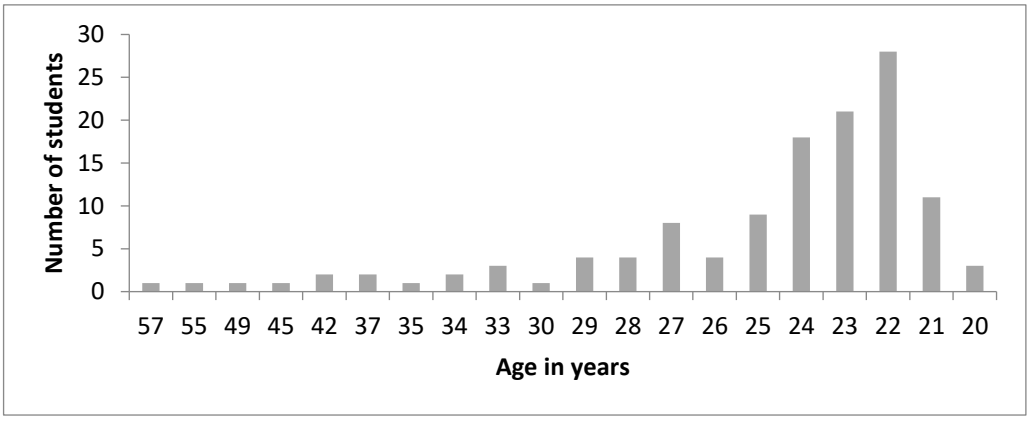


Figure 7.2 Age range for student sample group

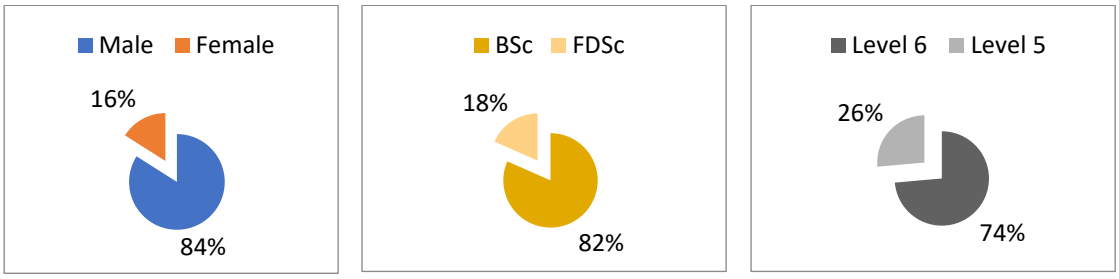


Figure 7.3 Demographic characteristics of student sample group

We now carry out some initial analysis of the 125 students' perceived competencies as recorded in their responses to the 20 competencies in the self-rating form (Figure 7.1). A test of Cronbach's Alpha for the 'before' competencies gave $\alpha = 0.96$, indicating a high level of consistency/reliability in the students' Likert scale answers to the 20 competencies. Similarly, for the 'after' competencies, Cronbach's Alpha

was 0.97. This high value of alpha is related to the large positive correlations between the students' responses to the competency questions, a matter that we return to later in Chapter 8 when we consider how we might reduce the number of competency questions. We therefore have a high degree of confidence that the self-rating form is reliably measuring the same latent variable, which is the perceived skill level.

7.3.2. Validating the competency framework for evaluating students' perceptions of their competencies with the use of t-tests

Before carrying out a statistical modelling exercise, we initially performed a series of t-tests to understand better the effect of our intervention on the differences in students' perceptions of the competencies.

7.3.2.1 Preliminary test of 'before and after' total competency scores

We compared the differences in students' self-assessed competencies at the start and end of their semester (or year depending on the student's circumstances) for all students in the sample. We conducted four independent 2 sample t-tests on the basis of whether students have taken a WRL module or not and also on the basis of whether they had received developmental feedback or not. The results are shown below and summarised in Table 7.2.

Test 1: comparing the difference in competence score *totalled over all 20 competencies* for those students who had studied the WRL module but received no developmental feedback. There was no strong evidence (p=0.07 for a 1-sided test) to reject the null hypothesis that the total after score was the same as the total before score.

Test 2: comparing the difference in competence score *totalled over all 20 competencies* for those WRL students who had received developmental feedback. The total after score for this group of students *was significantly* greater than the total before score (p=0.00002 for a 1-sided test).

Similarly, for those students who had not taken the WRL module, we carried out a 1-sided test of whether the total score of all competencies was greater at the end of the semester (or year) than at the start, separately considering receipt of feedback.

Test 3: comparing the difference in competence score *totalled over all 20 competencies* for those students who had **not** studied the WRL module and received no developmental feedback, there was some, but not strong, evidence that there was a greater score (p=0.03) at the end of the semester (or year) than at the beginning.

Test 4: comparing the difference in competence score *totalled over all 20 competencies* for those students who had **not** studied the WRL module and who had received developmental feedback, there was *no significant* difference (p=0.11) between scores at the start and end of the semester (or year).

Table 7.2 Summary of t-tests

		$\bar{x}_b$ before score	$\bar{x}_a$ after score	p-value for difference
WRL students	no developmental feedback	99.5 (17.2)	105.0 (19.1)	0.07
	developmental feedback	97.7 (12.5)	109.1 (13.5)	0.00002
Non WRL students	no developmental feedback	94.7 (8.0)	100.2 (7.0)	0.03
	developmental feedback	96.5 (9.4)	101.2 (9.2)	0.11

Standard deviation in parentheses

We note from Table 7.2 that there is very strong evidence that those students who took the WRL module and received feedback significantly increased their self-assessed total competencies by the end of the experience.

7.3.2.2 Difference test of 'before and after' total competency scores

Having noted the apparent variations in the total before and after competencies, we carried out significance tests using the differences between before ($\bar{x}_b$) and after ($\bar{x}_a$) total scores. In other words, we now included all students (i.e. those who had taken a WRL module and those who had not) and we tested the difference between the before and after scores by taking the difference between the total of the 20 self-evaluations for those who had and had not received developmental feedback, i.e. we considered ($\bar{x}_a - \bar{x}_{b)}$ for those who had or had not received developmental feedback.

We tested the following null and alternative hypotheses:

$$H_0: \text{feedback}(\bar{x}_a - \bar{x}_b) = \text{no-feedback}(\bar{x}_a - \bar{x}_b)$$
$$H_1: \text{feedback}(\bar{x}_a - \bar{x}_b) > \text{no-feedback}(\bar{x}_a - \bar{x}_b)$$

In the case of WRL students, there is a highly significant difference in ($\bar{x}_a - \bar{x}_b$) for those who had received development feedback than for those who had not received any feedback. (p=0.00005). However, for those students who did not undertake a WRL module, there is no significant difference in ($\bar{x}_a - \bar{x}_b$) if they had received the feedback or not. (p=0.32).

7.3.2.3 Comparisons of individual competencies

We now progress to testing each of the 20 competencies separately. As we are considering many tests on the same individuals, some form of correction in significance level is advisory. Here we use the Bonferroni correction, which means that with 20 competencies we should use a p-value of 0.05/20 = 0.0025.

For example, considering Competence 1 (Teamwork and relationship building) for students who had studied the WRL module, we tested the difference between a student's self-evaluation before and after receiving developmental feedback by considering the following hypothesis test:

H_0: feedback(after_Comp1 – before_Comp1) = no-feedback(after_Comp1 – before_Comp1)
H_1: feedback(after_Comp1 – before_Comp1) > no-feedback (after_Comp1 – before_Comp1)

In this case, we obtained a (one-sided) p-value of 0.026, indicating no strong evidence of a difference before and after feedback. Table 7.3 shows the results of the corresponding tests for all 20 competencies, where the WRL and non-WRL groups are shown separately.

Table 7.3 Individual Competency test results

Competencies	WRL			Non-WRL		
	$(\bar{x}_a - \bar{x}_b)$	1 sided p-value		$(\bar{x}_a - \bar{x}_b)$	1 sided p-value	
Workplace Competencies						
Teamwork and relationship building	0.31	0.026	*	0.34	0.1545	ns
Creative and innovative thinking	0.58	0.00003	**	0.49	0.0504	ns
Decision making and judgement	0.13	0.16	ns	0	0.5	ns
Planning, organisation and prioritising	0.74	0.00001	**	0.17	0.2975	ns
Business fundamentals/commercial awareness	0.63	0.0003	**	0.057	0.3226	ns
Working with tools and technology	0.42	0.001	**	0.036	0.4375	ns
Problem-solving and researching information	0.27	0.01	ns	0.0051	0.4909	ns
Customer focus / orientation	0.79	0.00001	**	0.16	0.1155	ns
Personal Effectiveness competencies						
Drive, initiative and results focus	0.13	0.12	ns	0.27	0.2142	ns
Adaptability and flexibility	0.13	0.11	ns	0.18	0.1853	ns
Self-management and self-motivation	0.64	0.0001	**	0.067	0.4309	ns
Professionalism	0.58	0.0004	**	0.097	0.2600	ns
Interpersonal effectiveness	0.33	0.02	ns	0.66	0.0116	ns
Integrity and reliability	0.42	0.00006	**	0.25	0.1436	ns
Academic competencies						
Reading/writing	-0.02	0.61	ns	0		
Listening/speaking	-0.02	0.61	ns	0		
Mathematics	-0.06	0.91	ns	0.077	0.1456	ns
Critical and Analytic thinking	0.17	0.05	*	0.11	0.2647	ns
Fundamental IT skills	0.02	0.71	ns	0		
Study skills	0.02	0.40	ns	0		ns

ns not significant
* $p<0.05$
** $p<0.0025$

Comparisons of individual competencies for the Work-Related Learning group

For those students who had experienced WRL, it is noticeable that there is no significant difference in virtually all the Academic competencies before and after developmental feedback, except some evidence of a difference in the case of 'critical and analytical thinking'. In the case of Personal Effectiveness competencies, there were significant improvements in their evaluation for 'self-management and self-motivation', 'professionalism' and 'integrity and reliability'.

Again, for those who had a WRL experience, for Workplace competencies there were highly significant differences in perceived competencies before and after feedback for 'creative and innovative thinking', 'planning, organisation and prioritising', 'business fundamentals/commercial awareness' and 'customer focus/orientation'. However, for the competencies of 'decision-making and judgement' and 'problem-solving and researching information' there was no significant difference.

Comparisons of individual competencies for the Non-Work-Related Learning group

For those students who had not experienced WRL, there were no significant improvements in their self-evaluation for *any* of the 20 competencies.

7.3.2.4 Discussion of t-test results

The results of the t-tests give an initial finding of improvement for WRL students who had received feedback. Moreover, and sensibly, this improvement is most evident within the Workplace competency category. However, developmental feedback did not prove particularly useful to those students who did not experience WRL, possibly because there were no workplace tasks to contextualise and practice the feedback.

7.3.3 Understanding how WRL and Feedback affect students' perception of competencies with the use of General Linear Modelling

In this section, we build statistical models for the difference in students' competencies in light of their experience of WRL and feedback. We will also be able to test whether there is an observed significant difference between the female and male students, between those studying BSc and Foundation courses and between those of different ages.

7.3.3.1 Modelling the Differences in Total Competencies

We compare the perceived competencies at the start and end of the modules, for those students who take the WRL module or not, and those who received feedback or not. Before making use of the general linear model to arrive at a best fit model, we use a P-P plot to determine if we can accept that a fundamental assumption in the model fitting is satisfied, namely that errors are normally distributed.

We begin building the linear model by generating the P-P plot of residuals (Figure 7.4) of the overall difference between before and after total competencies: *TOTALDIFF*.

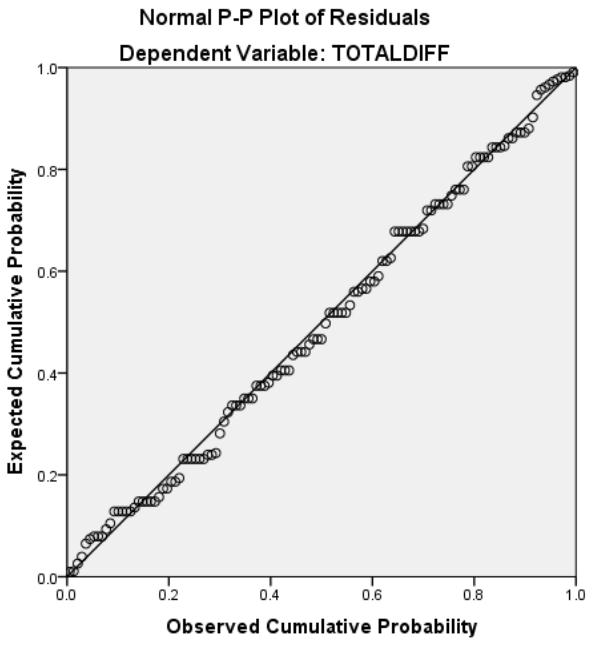


Figure 7.4 P-P plot of Residuals for *TOTALDIFF*

The P-P plot of standardised residuals is reasonably linear, indicating that the assumption of normality of errors is reasonable.

Our first model then is that the overall difference *TOTALDIFF* between before and after total competencies can be written as:

$$TOTALDIFF = \mu + F + WRL + F.WRL + \text{random error} \qquad \text{(Model 1)}$$

where μ is a constant, F is a 'factor' representing the feedback effect, WRL is a factor representing the Work-related Learning effect and F.WRL is the interaction between these two factors.

Using the General Linear Model program in SPSS, the fitted model gives the following linear predictor:

$$\begin{aligned} \text{Estimated } TOTALDIFF = 5.46 \quad & - 0.93 \text{ (if feedback = yes)} \\ & + 0.06 \text{ (if WRL = yes)} \\ & + 6.88 \text{ (if both yes)} \end{aligned} \qquad \text{(Eqn 1)}$$

We tested whether the interaction term (+6.88 if both yes) was needed in this model by comparing it with the simpler 'main effects' model, namely

$$TOTALDIFF = \mu + F + WRL + \text{random error.} \qquad \text{(Model 2)}$$

The test comparing model (1), with interaction, to the corresponding model (2) without the two-way interaction showed that the interaction term improved the fit of the model to the data (p=0.02). The 'current best' model (1) with linear predictor F+WRL+F.WRL gives the following fitted values in Table 7.4 for the estimated differences *TOTALDIFF*, shown to one significant d.p. (The numbers in parenthesis are the numbers of students in each group).

Table 7.4 Estimated competency differences for model (1)

		WRL	
Feedback		Yes	No
	Yes	11.5 (48)	4.5 (13)
	No	5.5 (49)	5.5 (15)

Comparing the possible effect on TOTALDIFF due to gender, type of degree or age.

Having noted that the above two-way interaction model was our 'current best' model, we tested for additional explanation of *TOTALDIFF* by the possible effects of GENDER (G), DEGREE TYPE (D) and AGE (either as a continuous variate or as a 3 level factor).

The initial new model that we then considered is of the form:

$$TOTALDIFF = \mu + F + WRL + F.WRL + G + D + AGE + \text{random error} \qquad \text{(Model 3)}$$

These additional three effects introduced together seemed non-significant, so we first removed the least significant, namely AGE (p=0.58), leaving the linear predictor:

$$\mu + F + WRL + F.WRL + G + D \qquad \text{(Model 4)}$$

We were then able to remove the next least significant (and non-significant) variable GENDER (p-value=0.31).

The linear predictor of our new 'best' current model, with degree type significant at p=0.002, was then:

$$\mu + F + WRL + F.WRL + D \qquad \text{(Model 5)}$$

We also tried a factor NAGE (AGE in three groups, <25, 25-30, >30) but this also offered no significant (p-value=0.90) improvement on our current 'best' model. The parameter estimates for the 'current best' model (5) are:

$$\begin{aligned} \textit{Estimated TOTALDIFF} = 7.28 \quad & + 0.93(\text{if F = No}) \\ & - 1.24(\text{if WRL = No}) \\ & - 7.26(\text{if one or both of F and WRL are no}) \\ & + 5.77(\text{if BSc}) \end{aligned} \qquad \text{(Eqn 2)}$$

Using equation (2), the fitted values for our new 'current best' model (5) for *TOTALDIFF* are displayed in Table 7.5.

Table 7.5 Estimated competency differences for model (5)

		BSc		FDSc
Feedback		WRL (Yes)	WRL (No)	WRL (Yes)
	Yes	13.0 (35)	4.5 (13)	7.3 (13)
	No	6.7 (39)	5.5 (15)	0.9 (10)

Both BSc and FDSc students who experienced both WRL and feedback markedly improved their perceptions of competency. We may note that, for BSc students who had not taken the WRL module, the fitted values in Table 7.5 are slightly smaller for those who had received feedback than those who had not. We tested this difference and noted it was not statistically significant (p=0.7).

Table 7.5 thus shows the fitted values for our overall best model for TOTALDIFF. Some BSc students took the WRL module, some did not. From Table 7.5 we can conclude that those BSc students who did take WRL had improved perceived competencies, and more markedly so for those who also received feedback. All FDSc students took the WRL module. Some BSc and some FDSc received feedback, some did not. For those taking the WRL module, perceived competencies were higher after receiving feedback. For the BSc students not taking the WRL module, feedback did not significantly change their perceived competencies.

7.3.3.2 Modelling the Differences in Workplace Competencies

Referring back to Table 7.3, which displays t-test results for individual competencies, we had noted that the most significant improvement in perceived individual competencies can be observed in the Workplace competency category. Hence, we considered that further modelling of the total eight Workplace competencies (as separate from the complete 20 competencies) could lead to interesting results. We followed the same process as in the previous modelling, where GENDER, DEGREE TYPE and NAGE were added to the current best model.

Our response variable was now the sum of only the differences in Workplace competencies. For this subset, we were able to remove NAGE (p-value=0.77) and then remove GENDER (p-value=0.63). However, DEGREE TYPE is significant with $p<0.0005$.

The final 'best' model for the difference in total Workplace competencies has parameter estimates as follows:

Estd. WORKPLDIFF = 4.19 + 0.24(if F = No)
- 0.72(if WRL = No)
- 4.09(if one or both of F and WRL are no)
+ 3.31(if BSc)

The corresponding fitted values are given in Table 7.6.

Table 7.6 Estimated competency differences for workplace competencies

		BSc		FDSc
Feedback		WRL (Yes)	WRL (No)	WRL (Yes)
	Yes	7.5 (35)	2.7 (13)	4.2 (13)
	No	3.7 (39)	2.9 (15)	0.4 (10)

The BSc students who did the WRL module and received feedback improved their perception of Workplace competencies by 7.5 on average, which is twice that of those who did not receive feedback. For those BSc students who did not take the WRL module, there was no improvement in their perceived Workplace competencies after receiving feedback. For FDSc students, all of whom took the WRL module, those who received feedback had a higher positive difference (of 4.2) in their perceived Workplace competencies compared to those without any feedback (0.4).

It is noteworthy that the BSc students with WRL and feedback had an increase in ratings for Workplace competencies of 7.5 compared to the same FDSc group who had an increase of 4.2. We note that these effects appear to be independent of any gender or age effect.

Noting that the total workplace competency differences are summed over the 8 workplace competencies whereas the total difference in competencies is summed over 20 competencies, the above table seems compatible with the previous table (Table 7.5) of all competencies. Moreover, worthy of note is that those competencies related to the workplace generally contribute over 50% improvement in skills.

7.3.3.3 Discussion of modelling results

The use of general linear modelling has allowed us to determine observed differences in the perception of competencies by students in the sample. We have concluded that gender and age do not play a significant role in determining student perceptions, whereas the type of degree that students are undertaking does appear to be a relevant aspect. Factors contributing to this variability could include the fact that students on degree types of BSc and FDSc have different backgrounds and would have entered their courses with different qualifications, academic experiences and skills.

7.3.4 Understanding the Student Groupings using Cluster Analysis and Boxplots of Competencies

In order to better understand students' perceptions of their competencies, we carried out a cluster analysis of 125 students in terms of their total perceived competencies score before and after taking the WRL module. A series of boxplots were then generated to explore graphically the distribution of competency scores.

7.3.4.1 Clustering students into clusters with similar total competency scores

Several clustering runs were generated (using K-Means cluster analysis) but the most meaningful clustering uses 4 clusters. The number of cases in each cluster is shown in the SPSS output of Table 7.7, in which we note that cluster 1 has only one member, namely student 35 with a total competency score of 40. More information on each cluster is shown in Table 7.8, whilst Figure 7.5 shows a boxplot of the total competency score for each cluster. From this figure, and Table 7.7, there is clearly almost no overlap between the clusters. Cluster 2 consists of students who have high scoring perceived total competencies averaging 119 and therefore most likely to be scoring 6 per competency. Note, from Figure 7.5, that students 14, 42 and 88 are extremes of Cluster 2 as these three students have scored themselves 7 throughout. Cluster 3 has the lowest scoring perceived competencies, with 48 students averaging around 86. Note, again from Figure 7.5 that students 15 and 43 are outliers of Cluster 3 as each of these two students has scored themselves a total of 71, this score being the minimum for this cluster. Cluster 4 has mid-range scoring perceived competencies, averaging 5 for each competency.

Table 7.7 Number of Cases in each Cluster

Cluster	1	1
	2	27
	3	48
	4	49
Valid		125
Missing		0

Table 7.8 Cluster Statistic Details

Cluster Number of Case	Mean	N	Std. Deviation	Minimum	Maximum	Median
1	40	1	.	40	40	40
2	118.9	27	8.0	111	140	116
3	86.5	48	5.1	71	93	89
4	98.8	49	3.4	92	104	97
Total	97.9	125	14.2	40	140	97

Output shown to 1 d.p.

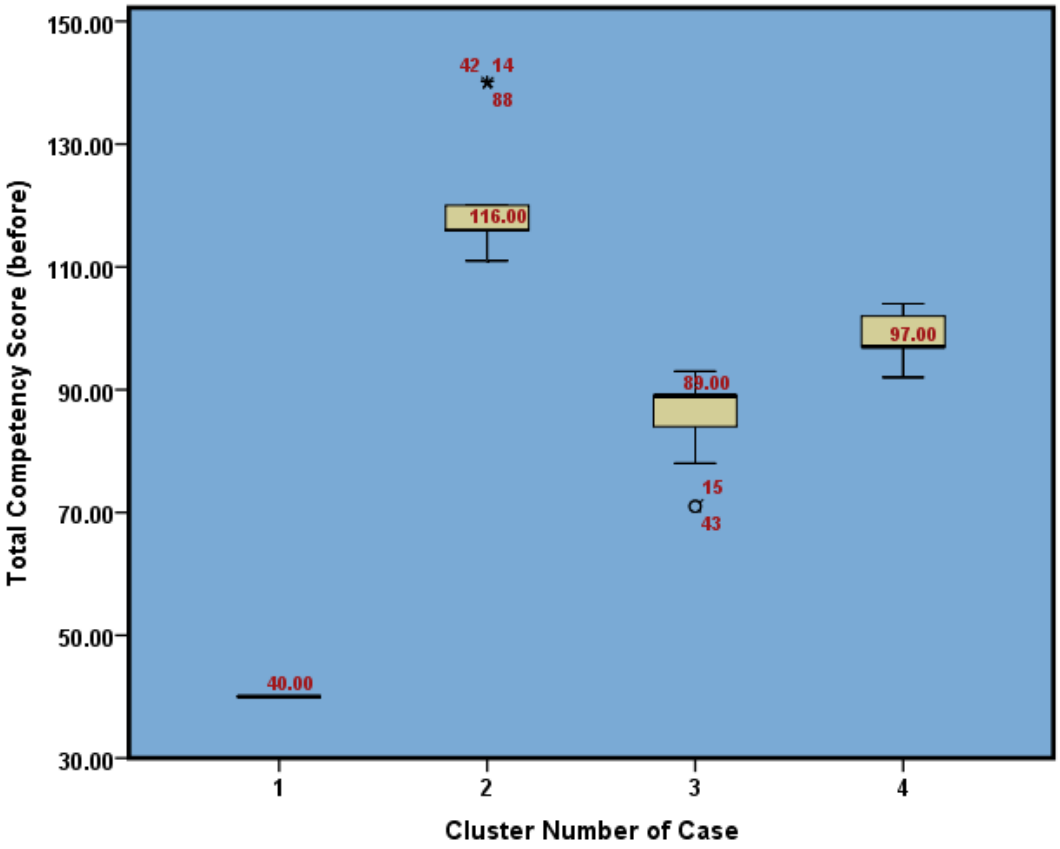


Figure 7.5 Boxplot of Total Competency Scores for 4 Clusters showing Median

Note: symbol 'o' represents an outlier
symbol '*' represents an extreme value, as determined by SPSS's internal procedures.

We also produced a number of boxplots of the individual factors of WRL, Feedback and Degree for both 'before' and 'after' total competency scores which can be found in Appendix D. Although these give us some idea of the variabilities within the four clusters, it is the boxplots (Figures 7.6, 7.7 and 7.8) which combine all 3 factors that are of greater interest.

We initially produced the boxplot (Figure 7.6) of the total competency 'before' scores considering the three factors WRL, Feedback and Degree. We also produced the corresponding table of summary statistics shown in Table 7.9. Cluster 1 is the singleton with a very low score (40) before and after. Cluster 2 comprises of the highest scoring, mostly attributed to the FDSC students. The groups within Cluster 2 have considerable variability and statistically significant skewness. Cluster 3 has medians in the high 80s, whilst those for cluster 4 tend to be in the high 90/100s. In cluster 3 the whiskers belonging to (WRL=1_F=0_D=0) and (WRL=1_F=0_D=1) factors are more pronounced and longer, indicating greater variability within these categories of students. In cluster 4 the (WRL=1_F=0_D=0) group of 4 students has significant positive skewness. Comparing the 6 groups overall (i.e. not within clusters) the FDSc students generally had greater variability than the BSc students although (WRL=1_F=0_D=1) also had large variability.

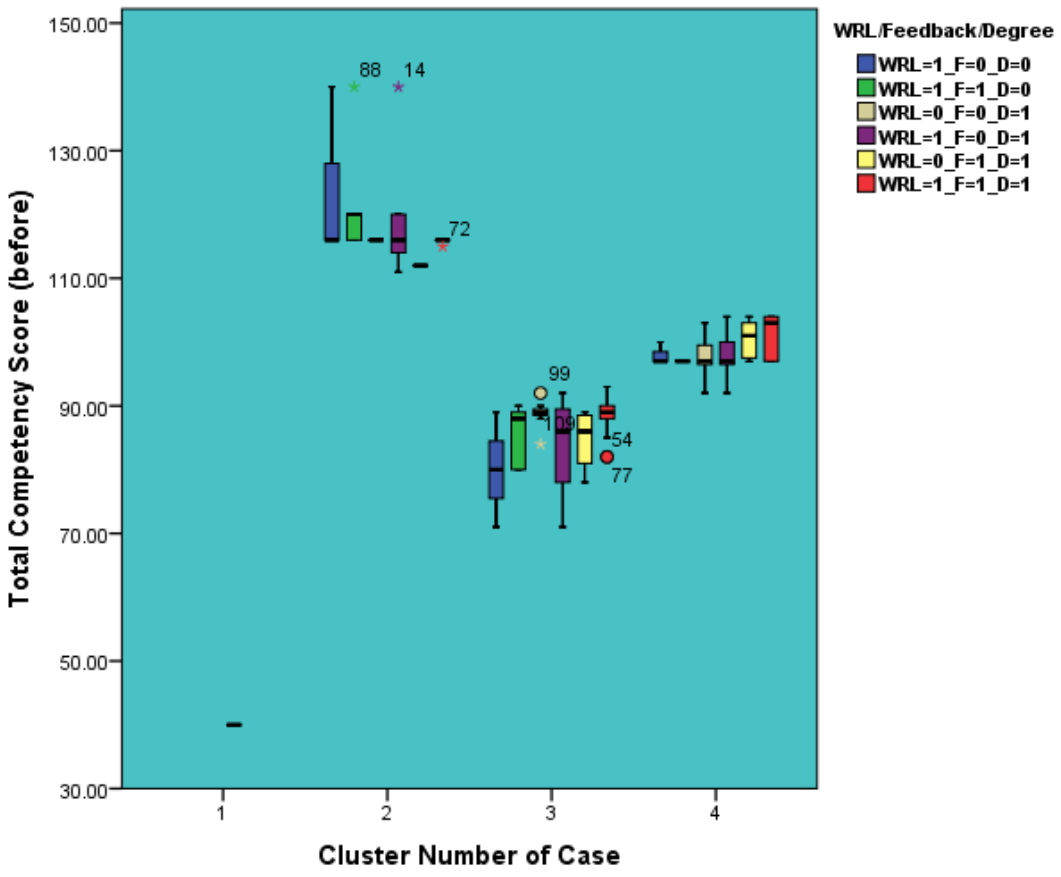


Figure 7.6 Total 'before' Competency Scores for 4 Clusters

Note: For WRL: 1 is yes, 0 is no, For Feedback: 1 is yes, 0 is no, For Degree: 1 is BSc, 0 is FDSc

Table 7.9 Cluster Details of Total 'before' Competencies

Cluster for 4 K means	WRL/Feedback/Degree	Mean	N	Std. Deviation	Skewness	Median	Minimum	Maximum
1	WRL=1_F=0_D=1	40	1	.	.	40	40	40
	Total	40	1	.	.	40	40	40
2	WRL=1_F=0_D=0	124	3	13.9	1.7	116	116	140
	WRL=1_F=1_D=0	122.4	5	10.0	2.0	120	116	140
	WRL=0_F=0_D=1	116	1	.	.	116	116	116
	WRL=1_F=0_D=1	118.4	11	7.9	2.2	116	111	140
	WRL=0_F=1_D=1	112	1	.	.	112	112	112
	WRL=1_F=1_D=1	115.8	6	.4	-2.4	116	115	116
	Total	118.8	27	8.0	2.1	116	111	140
3	WRL=1_F=0_D=0	80	3	90	0	80	71	89
	WRL=1_F=1_D=0	85.4	5	4.9	-.5	88	80	90
	WRL=0_F=0_D=1	88.7	7	2.4	-1.1	89	84	92
	WRL=1_F=0_D=1	83.7	8	7.4	-.6	86	71	92
	WRL=0_F=1_D=1	84.7	4	4.9	-1.1	86	78	89
	WRL=1_F=1_D=1	88.2	21	2.8	-11	89	82	93
	Total	86.4	48	5.1	-1.4	89	71	93
4	WRL=1_F=0_D=0	97.7	4	1.5	2	97	97	100
	WRL=1_F=1_D=0	97	3	0	.	97	97	97
	WRL=0_F=0_D=1	97.7	7	3.7	.1	97	92	103
	WRL=1_F=0_D=1	97.8	19	3.4	.1	97	92	104
	WRL=0_F=1_D=1	100.5	8	2.9	-.1	101	97	104
	WRL=1_F=1_D=1	101.1	8	3.4	-.5	103	97	104
	Total	98.7	49	3.4	.1	97	92	104
Total	WRL=1_F=0_D=0	100.3	10	19.7	.6	97	71	140
	WRL=1_F=1_D=0	102.3	13	18.3	.6	97	80	140
	WRL=0_F=0_D=1	94.7	15	7.9	1.3	92	84	116
	WRL=1_F=0_D=1	99.3	39	16.8	-.7	97	40	140
	WRL=0_F=1_D=1	96.5	13	9.4	-.5	98	78	112
	WRL=1_F=1_D=1	95.9	35	10.9	.8	90	82	116
	Total	97.9	125	14.2	.1	97	40	140

Output shown to 1 d.p.

Next, we plotted the difference of total competencies for the three factors, as shown in Figure 7.7 for which the summary statistics appear in Table 7.10. What we know already from the raw data is that 11 students recorded a negative difference score, 15 students experienced no overall change in their total before and after scores, the remaining 99 students did record a positive difference score with the highest difference being a score of 24. Of note in Figure 7.7 are certain factor groups, for example, (WRL=1_F=1_D=1) has the highest difference scores in clusters 2, 3 and 4, although there is some variability in cluster 3 with several outliers. Also of note is the (WRL=1_F=1_D=0) group, in green, in cluster 3 which has a high median but a particularly long tail. The students in the (WRL=1_F=1_D=0) group generally have higher differences than their corresponding colleagues, (WRL=1_F=0_D=0) in blue, without feedback. In Cluster 2 there are two groups, (WRL=0_F=0_D=1) and (WRL=0_F=1_D=1), containing only one student.

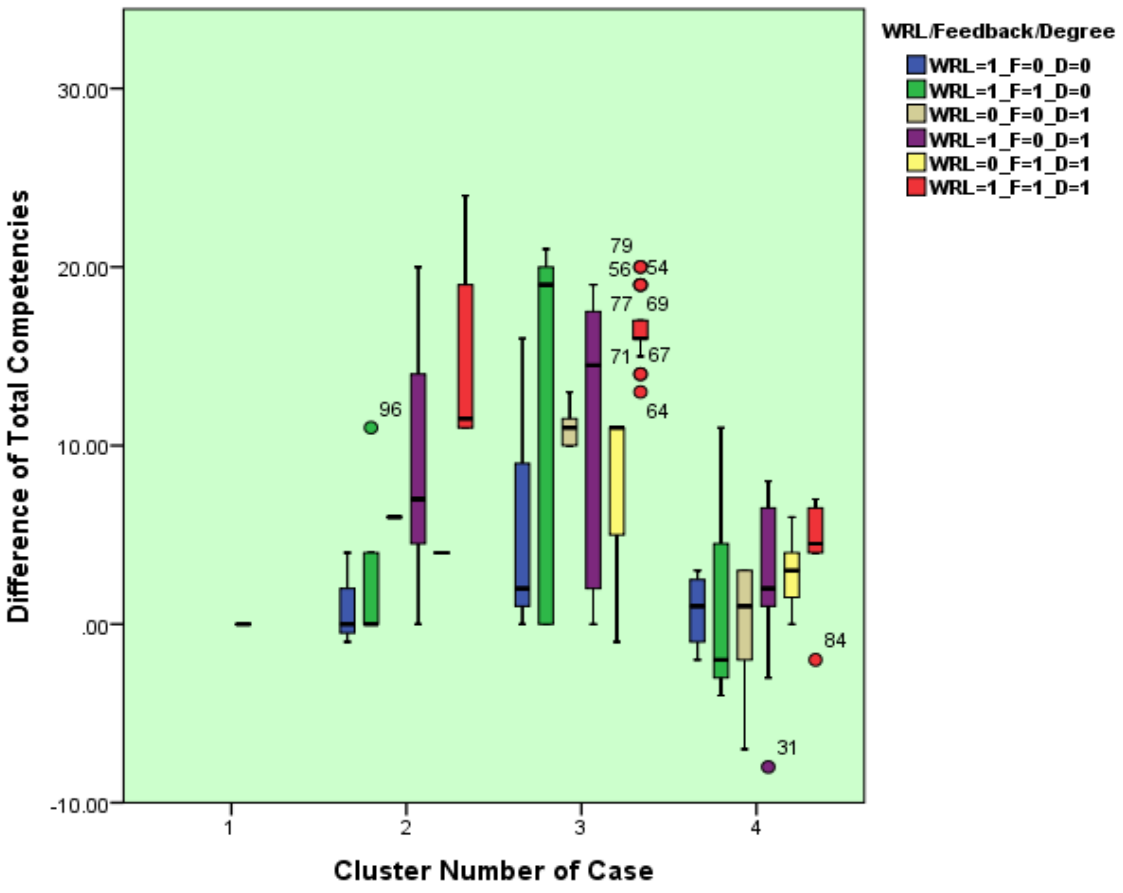


Figure 7.7 Difference of Total Competency Scores for 4 Clusters

Note: For WRL: 1 is yes, 0 is no, For Feedback: 1 is yes, 0 is no, For Degree: 1 is BSc, 0 is FDSC

Table 7.10 Cluster Details of Difference Scores

Cluster for 4 K means	WRL/Feedback/Degree	Mean	N	Std. Deviation	Skewness	Median	Minimum	Maximum
1	WRL=1_F=0_D=1	0	1	.	.	0		
	Total	0	1	.	.	0		
2	WRL=1_F=0_D=0	1	3	2.6	1.4	0	-1	4
	WRL=1_F=1_D=0	3	5	4.7	1.6	0		11
	WRL=0_F=0_D=1	6	1	.	.	6	6	6
	WRL=1_F=0_D=1	9.6	11	6.6	.4	7		20
	WRL=0_F=1_D=1	4	1	.	.	4	4	4
	WRL=1_F=1_D=1	14.6	6	5.5	1.2	11.5	11	24
	Total	8.2	27	7.0	.5	7	-1	24
3	WRL=1_F=0_D=0	6	3	8.7	1.6	2		16
	WRL=1_F=1_D=0	12	5	10.9	-.5	19		21
	WRL=0_F=0_D=1	11	7	1.1	.9	11	10	13
	WRL=1_F=0_D=1	10.8	8	8.0	-.5	14.5		19
	WRL=0_F=1_D=1	8	4	6	-2	11	-1	11
	WRL=1_F=1_D=1	16.5	21	1.9	.2	16	13	20
	Total	12.9	48	6.3	-1.0	15	-1	21
4	WRL=1_F=0_D=0	.7	4	2.2	-.4	1	-2	3
	WRL=1_F=1_D=0	1.6	3	8.1	1.6	-2	-4	11
	WRL=0_F=0_D=1	-.1	7	3.8	-1.0	1	-7	3
	WRL=1_F=0_D=1	2.8	19	4.0	-.9	2	-8	8
	WRL=0_F=1_D=1	2.8	8	2.0	-.3	3		6
	WRL=1_F=1_D=1	4.3	8	2.8	-1.7	4.5	-2	7
	Total	2.4	49	3.8	-.4	3	-8	11
Total	WRL=1_F=0_D=0	2.4	10	5.1	2.4	1	-2	16
	WRL=1_F=1_D=0	6.1	13	9.0	.7	0	-4	21
	WRL=0_F=0_D=1	5.4	15	6.1	-.5	6	-7	13
	WRL=1_F=0_D=1	6.3	39	6.8	.5	5	-8	20
	WRL=0_F=1_D=1	4.5	13	4.1	.6	4	-1	11
	WRL=1_F=1_D=1	13.4	35	5.8	-.8	16	-2	24
	Total	7.7	125	7.3	.2	6	-8	24

Output shown to 1 d.p.

Finally, we produced the boxplot (Figure 7.8) of the total competency 'after' scores considering the three factors WRL, Feedback and Degree. We also produced the corresponding table of summary statistics shown in Table 7.11. For the 'after'

competencies there is again a cluster (now numbered 4) with a single student. Cluster 3 has 8 students (of the 48 in the 'before' cluster 3). Cluster 2 are 25 high-scoring students similar to the 27 in the 'before' cluster 2. Cluster 1 has 91 students with similar scores across all six WRL, F and D groupings, indicating that three quarters of students now had the same understanding of competencies in contrast to the variability in the clusters in the 'before' competencies (i.e. to a large extent combining the students in clusters 3 and 4 of the 'before' competencies).

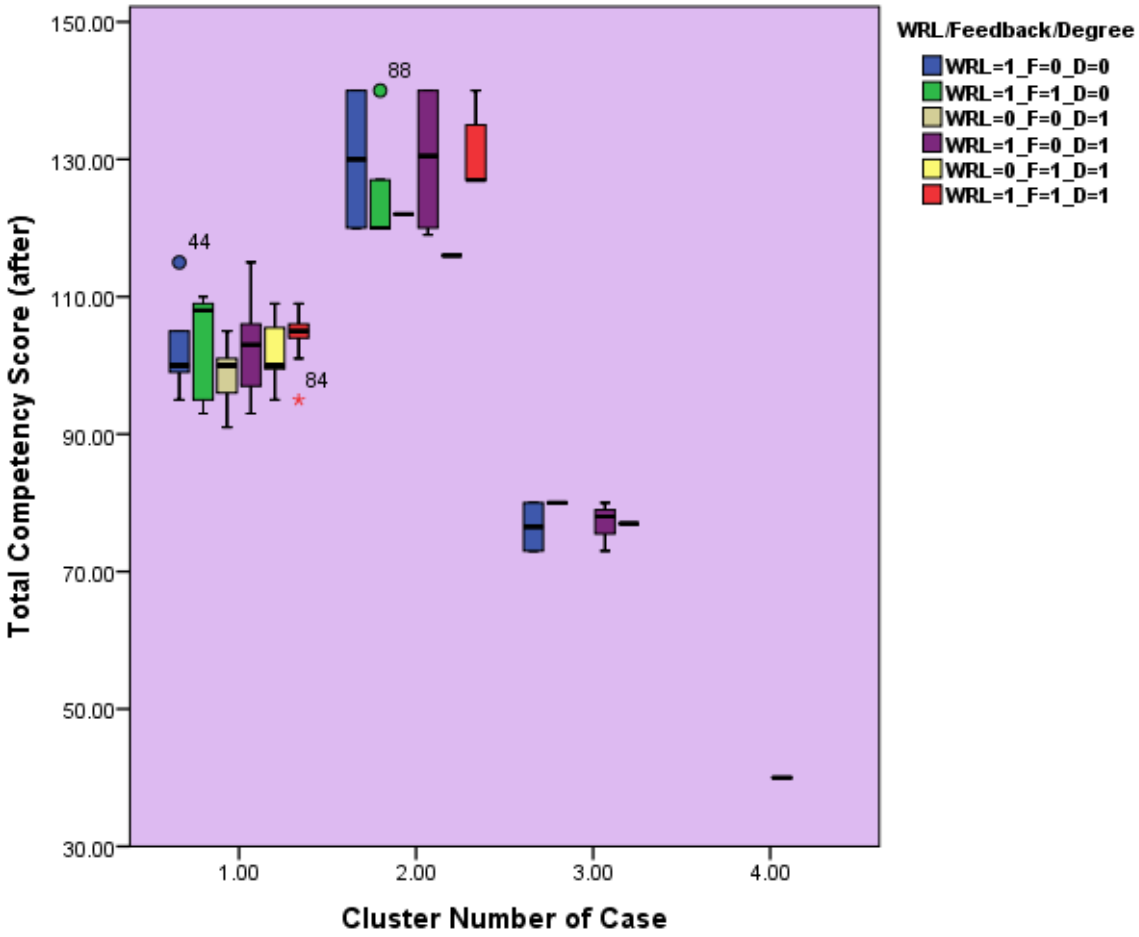


Figure 7.8 Total 'after' Competency Scores for 4 Clusters

Note: For WRL: 1 is yes, 0 is no, For Feedback: 1 is yes, 0 is no, For Degree: 1 is BSc, 0 is FDSC

Table 7.11 Cluster Details of Total 'after' Competency Scores

Cluster for 4 K means	WRL/Feedback/Degree	Mean	N	Std. Deviation	Skewness	Median	Minimum	Maximum
1	WRL=1_F=0_D=0	102.3	6	6.9	1.4	100	95	115
	WRL=1_F=1_D=0	103.8	6	7.6	-.9	108	93	110
	WRL=0_F=0_D=1	98.6	14	3.7	-.4	100	91	**105**
	WRL=1_F=0_D=1	102.2	25	5.3	.2	103	93	115
	WRL=0_F=1_D=1	101.9	11	4.4	.3	100	95	109
	WRL=1_F=1_D=1	105	29	2.6	-1.8	105	95	109
	Total	102.6	91	4.9	-.1	104	91	115
2	WRL=1_F=0_D=0	130	2	14.1	.	130	120	140
	WRL=1_F=1_D=0	125.4	5	8.7	1.6	120	120	140
	WRL=0_F=0_D=1	122	1	.	.	122	122	122
	WRL=1_F=0_D=1	129.4	10	9.1	.01	130.5	119	140
	WRL=0_F=1_D=1	116	1	.	.	116	116	116
	WRL=1_F=1_D=1	130.5	6	5.6	1.2	127	127	140
	Total	128.0	25	8.4	.3	127	116	140
3	WRL=1_F=0_D=0	76.5	2	4.9	.	76.5	73	80
	WRL=1_F=1_D=0	80	2	0	.	80	80	80
	WRL=1_F=0_D=1	77	3	3.6	-1.1	78	73	80
	WRL=0_F=1_D=1	77	1	.	.	77	77	77
	Total	77.62	8	3.1	-.9	79	73	80
4	WRL=1_F=0_D=1	40	1	.	.	40	40	40
	Total	40	1	.	.	40	40	40
Total	WRL=1_F=0_D=0	102.7	10	19.2	.4	100	73	140
	WRL=1_F=1_D=0	108.4	13	17.7	-.1	109	80	140
	WRL=0_F=0_D=1	100.2	15	7.0	2.2	100	91	122
	WRL=1_F=0_D=1	105.6	39	19.3	-.6	104	40	140
	WRL=0_F=1_D=1	101.1	13	9.1	-1.2	100	77	116
	WRL=1_F=1_D=1	109.3	35	10.2	1.7	105	95	140
	Total	105.6	125	15.0	-.2	105	40	140

Output shown to 1 d.p.

7.3.4.2 Boxplot of Fitted Model

The best fitting model to explain the variability in competency differences is given in Model 5 of Section 7.3.3.1. The significant explanatory factors are WRL, Feedback and Degree and it is therefore of interest to plot each of the 6 cases of factor combinations in parallel, according to the difference in total competency ratings. Figure 7.9 is the boxplot for the difference scores for WRL/Feedback/Degree factors and Figure 7.10 is the profile plot of fitted competencies from the best model as determined in Section 7.3.3.1, both of which clearly show graphically the higher total difference scores in the (WRL=1_F=1_D=1) factor, that is to say that BSc students who undertook WRL and received feedback perceived an improvement in their competencies.

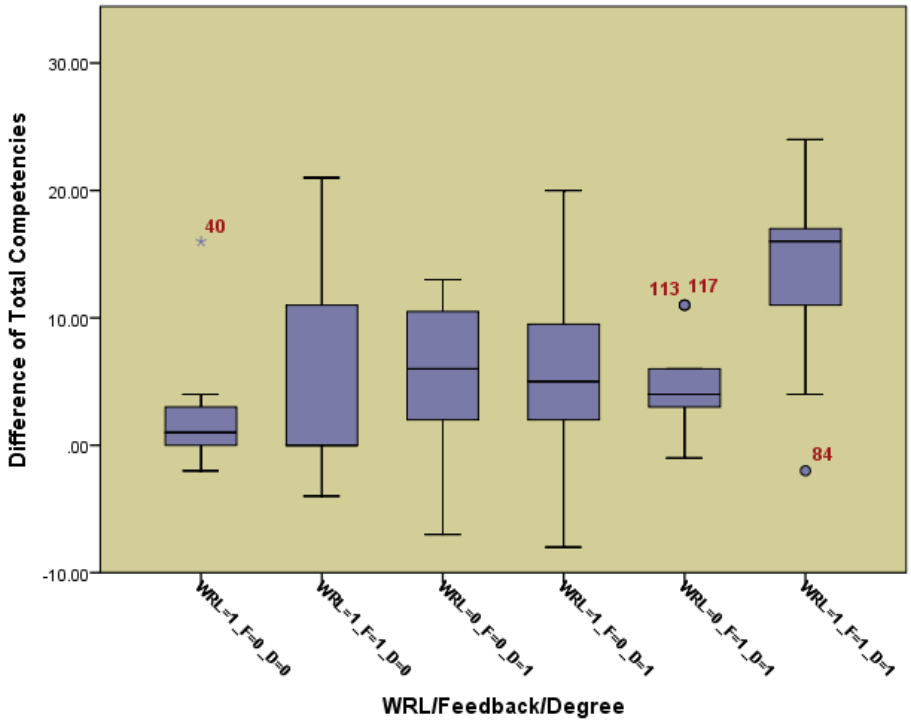


Figure 7.9 Difference of Total Competency Scores for WRL/Feedback/Degree

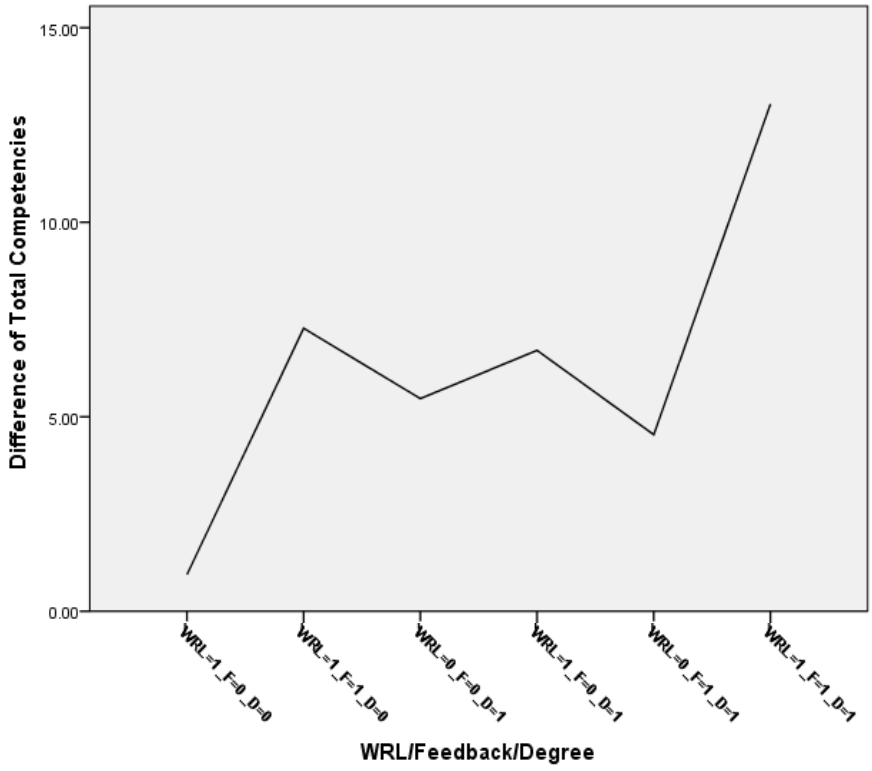


Figure 7.10 Fitted Total Scores for WRL/Feedback/Degree

7.3.4.3 Discussion of cluster analysis results

Cluster analysis has been useful in the investigation of potential groupings of students on the basis of their self-rated competency scores. Some general points of interest include:

a) Approximately one fifth of all students rate themselves highly. This is useful to measure as it allows for the consideration of participants who are overly confident in their self-belief.
b) BSc and FDSc students do display slightly different behaviour in that the FDSc students generally lean towards rating themselves higher than their BSc counterparts. When providing developmental feedback, it is of use to know which students are more likely to overestimate their capabilities.
c) The clusters noticeably vary 'before' and 'after', which confirms that the WRL and feedback leads students to improve perceived competencies over time.

d) The majority (91/125) of students are clustered into one large cluster in the 'after' analysis – these could be thought of as the 'improvers'.
e) The larger cluster (1) in the 'after' total competency (91) indicates that students have migrated to a better perception of their competencies; this is mainly due to BSc students improving perceptions of competencies after receiving feedback or attending the WRL module or both.
f) We did not witness any gender difference in this particular sample, but with a sample of only 16% female students any difference would be difficult to show as statistically significant. Possible gender differences could be an aspect to seek to further investigate with a sample containing more women.

7.3.5 Understanding the relationship between competency measures with the use of Principal Component Analysis

We now proceed with the transformation known as Principal Component Analysis (PCA) to better understand the variability of the competency ratings. Since we have 20 such competencies, PCA will allow us to gain a perspective of the internal structure of the students' ratings and how varied those ratings are. In particular, with this type of analysis, we will be able to determine whether the variations in the scoring of the 20 competencies (observed variables) are mainly reflected by variations in a very much smaller subset of unobserved (underlying) variables. Therefore, our aim is to consider only the few principal components in order to reduce the dimensionality of the transformed data and ideally reveal a simpler structure.

Prior to carrying out any transformation though, it is useful to initially consider the scree plot of the PCA eigenvectors as shown in Figure 7.11.

The scree plot clearly shows (at the 'elbow') that there are at most only 3 or 4 dimensions here. 3 components account for 84% of the variation (4 components account for 90%) in the responses of the 125 students regarding the 20 competencies.

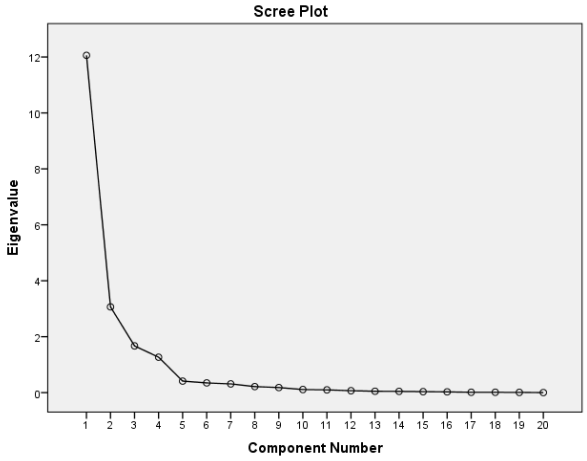


Figure 7.11 Scree Plot

7.3.5.1 PCA transformation for 'before' competencies

SPSS PCA allows various rotations including varimax and quartimax. We apply rotation here to redistribute the total variance extracted by the given factors so that each factor is represented with positive loadings where possible. We tried both varimax and quartimax rotations using (only) the 'before' ratings. Since the quartimax rotation gave more readily interpretable components, we use it throughout this analysis. The quartimax rotated component matrix for 'before' competencies is given in Table 7.12. We here show 4 (out of the possible 20) principal components, together with the percentage of the total variance explained by each of these 4 components.

Table 7.12 Component matrix and percentage of total variance for the 'before' competencies after quartimax rotation

	Component			
	PC1	PC2	PC3	PC4
Teamwork and relationship building (before)	.852	.285	.070	.233
Creative and innovative thinking (before)	.887	.063	-.068	.177
Decision making and judgement (before)	.877	.105	.351	.057
Planning, organisation and prioritising (before)	.851	.005	.197	-.403
Business fundamentals/commercial awareness (before)	.920	-.155	.164	-.044
Working with tools and technology (before)	.773	-.042	-.054	-.547
Problem-solving and researching information (before)	.922	.062	.180	-.010
Customer focus/orientation (before)	.948	-.036	-.058	.090
Drive, initiative and results focus (before)	.859	.311	-.127	-.173
Adaptability and flexibility (before)	.924	.025	-.237	-.020
Self-management and self-motivation (before)	.777	.023	.532	-.021
Professionalism (before)	.766	.076	.098	.521
Interpersonal effectiveness (before)	.739	.137	-.412	.450
Integrity and reliability (before)	.817	.338	-.325	-.104
Reading/writing (before)	.350	.928	.051	-.006
Listening/speaking (before)	.318	.933	.039	-.002
Mathematics (before)	.742	.231	-.443	-.237
Critical and Analytic thinking (before)	.416	.779	.092	.348
IT skills (before)	.305	.772	-.416	-.153
Study skills (before)	.247	.683	.639	-.068
	% of Variance			
	56.5	19.0	8.3	6.4

We note that the first two components contribute approximately three quarters of the variability for the 125 student ratings. The highlighted values for PC1 are all the non-academic competencies, together with 'mathematics', whereas the highlighted values for PC2 are the academic competencies without 'mathematics'.

The scatter plot (Figure 7.12) of PC1 against PC2 indicates 3 main groups of students. There is a clear distinction between those who express a strong competency in PC2 and those who do not; the vertical cut-off shown in the plot is just above zero, the sample mean of PC2. Also for those who have a high competence in PC2 there are two groups – one with high expressed competency in PC1 and one without; the horizontal cut-off is approximately zero, the sample mean of PC1.

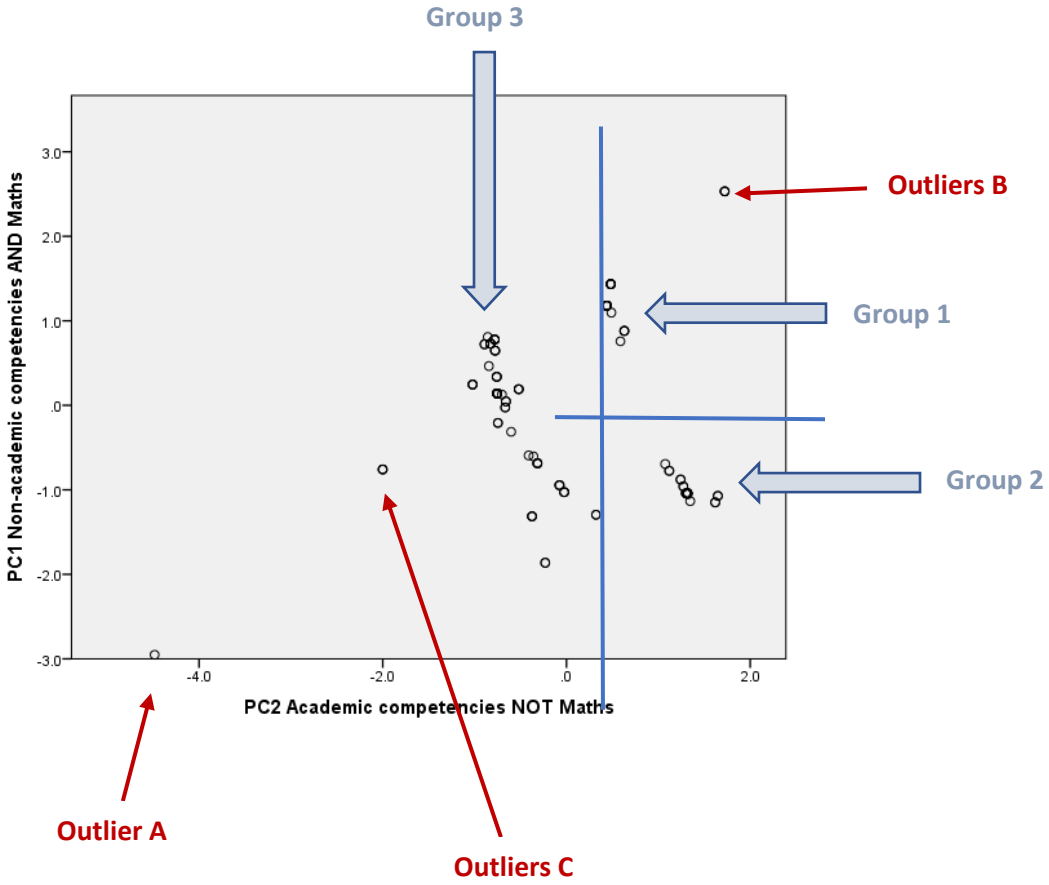


Figure 7.12 Plot of PC1 against PC2 for 'before' competencies

7.3.5.2 Outliers and Groups explained

The dots displayed in the SPSS plot shown in Figure 7.12 represent one or more students. It is useful to generate the corresponding labelled plot shown in Figure 7.13 to explain better the groups and outliers.

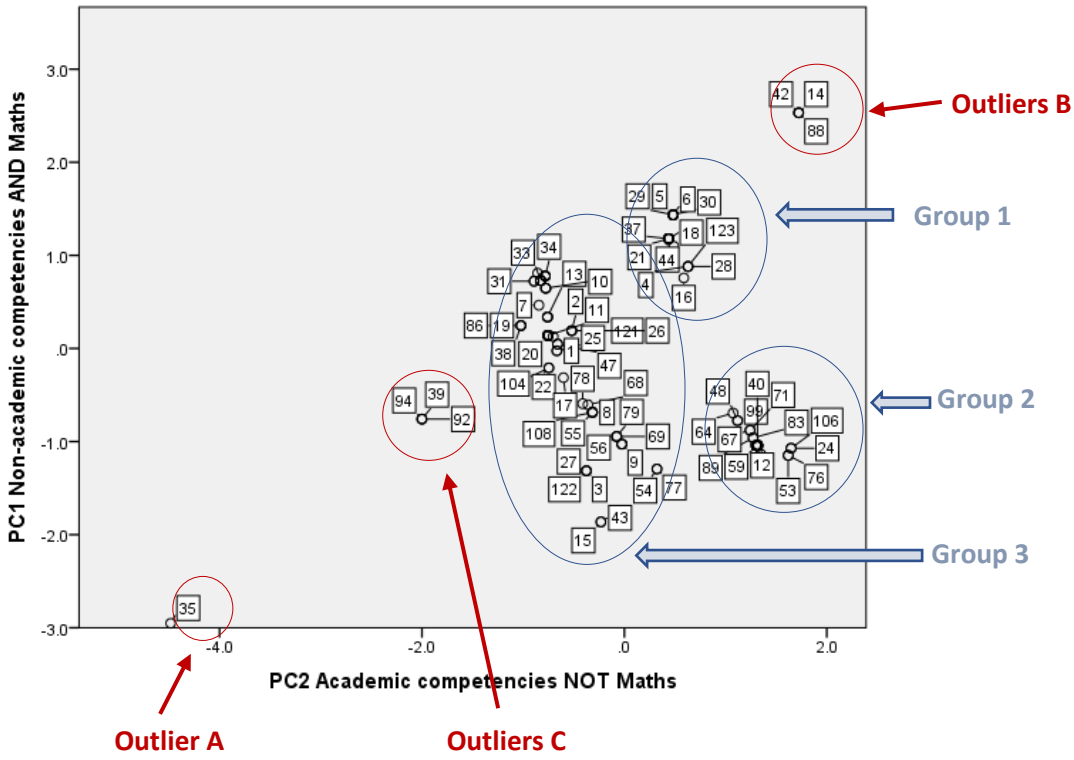


Figure 7.13 Plot of PC1 against PC2 for 'before' competencies with case numbers identified.

Group 1: This group expresses a strong competency in both PC1 and PC2; i.e. that they feel broadly highly competent in all 20 competencies. This is a relatively small group of 12 students.

Group 2: This group expresses a strong competency in PC2 but a less strong competency in PC1; i.e. they feel confident about the Academic competencies, excluding Mathematics but they are less confident about the Workplace and Personal Effectiveness competencies.

Group 3: This group expresses less confidence in the Academic competencies, excluding Mathematics, and their rating of their Workplace and Personal

Effectiveness competencies is spread across the whole range. The largest group of students fall into this category.

Outlier A: (Student #35). This student rated himself on the competency scale as 2 throughout all 20 competencies.

Outliers B: (Students #14, 42, 88). These three students rated themselves on the competency scale as 7 throughout all 20 competencies.

Outliers C: (Students #39, 92, 94). These three students rated themselves on the competency scale as 4 throughout all 20 competencies.

In addition, there are students who have rated themselves at the same rating (5 or 6) throughout all 20 competencies – although these are not as visible on the labelled plot.

7.3.5.3 PCA transformation for 'after' competencies

A PCA with quartimax rotation was executed for the 'after' competencies in the same way. The resulting rotation matrix (Table 7.13) shows 2 principal components. 64% of the variability is explained by the first component PC1, which is effectively a scaled sum of all the competency scores. PC2 explains 10% of the variability; its loadings principally weight 3 out of the 6 academic competencies, namely 'reading/writing', 'listening/speaking' and 'IT skills'.

Table 7.13 Component matrix and percentage of variance explained for the 'after' competencies

	Component	
	PC1	PC2
Teamwork and relationship building (after)	.800	.182
Creative and innovative thinking (after)	.874	.060
Decision making and judgement (after)	.794	-.291
Planning, organisation and prioritising (after)	.864	.016
Business fundamentals/commercial awareness (after)	.813	-.380
Working with tools and technology (after)	.822	.002
Problem-solving and researching information (after)	.898	-.108
Customer focus/ orientation (after)	.833	-.331
Drive, initiative and results focus (after)	.886	-.254
Adaptability and flexibility (after)	.810	-.421
Self-management and self-motivation (after)	.741	-.145
Professionalism (after)	.716	-.106
Interpersonal effectiveness (after)	.830	.305
Integrity and reliability (after)	.825	.472
Reading/writing (after)	.780	.491
Listening/speaking (after)	.769	.506
Mathematics (after)	.745	-.026
Critical and Analytic thinking (after)	.787	.360
IT skills (after)	.749	.572
Study skills (after)	.592	.147
	% of Variance	
	63.8	9.8

By plotting PC1 against PC2 (Figure 7.14) we can observe that there are no evident groupings of students. The only clear outlier is student 35 who rated himself on the competency scale as 2 throughout all 20 competencies.

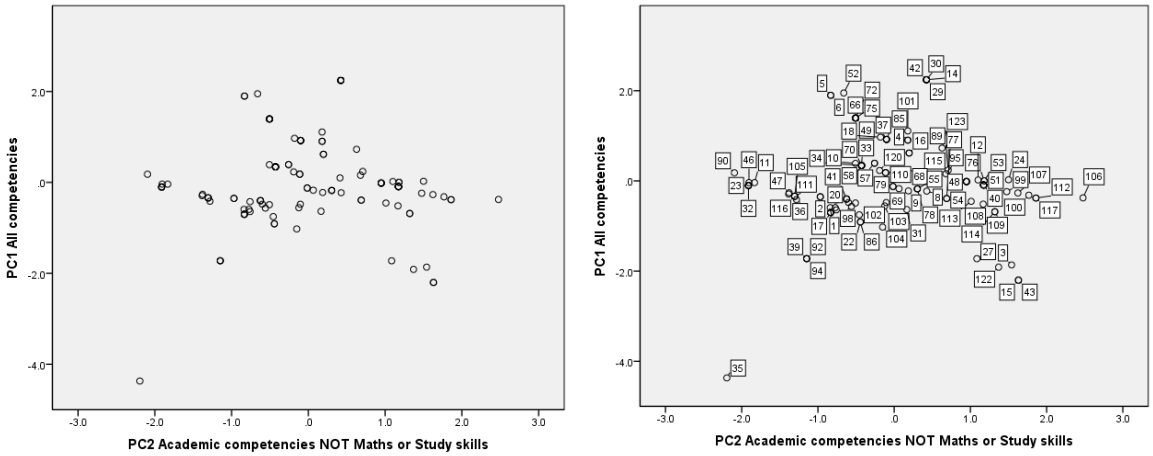


Figure 7.14 Plot of PC1 against PC2 for 'after' competencies

7.3.5.4 PCA transformation for the differences between 'before' and 'after' competencies

Lastly, we executed a PCA with quartimax rotation for the differences between 'before' and 'after' competencies. This PCA (Table 7.14) indicated 6 eigenvalues greater than 1, with PC1 only explaining 26% of the variation in the perceived competency scores and PC2 explaining 19%. Bearing in mind the low amount of variability explained by the first principal components a plot of PC1 against PC2 would not give a strong representation of how the total variability was spread across groups of students. It may however be of interest to note that the most important component PC1 consists of the total difference in scores over the Workplace and Personal effectiveness competencies except 'adaptability and flexibility'. PC2 consists of the total difference in scores over academic competencies with less emphasis on 'critical analysis' and 'study skills'.

Table 7.14 Component matrix and percentage of variance explained for the difference in competencies

	Component					
	1	2	3	4	5	6
Teamwork and relationship building (difference)	.539	-.015	-.021	.006	.653	.013
Creative and innovative thinking (difference)	.790	.065	.131	-.207	-.314	-.164
Decision making and judgement (difference)	.298	.117	.090	.252	.138	.760
Planning, organisation and prioritising (difference)	.814	.012	.194	.188	.225	.181
Business fundamentals/commercial awareness (difference)	.554	.021	.684	.134	-.057	.240
Working with tools and technology (difference)	.706	.182	.184	-.242	-.033	.063
Problem-solving and researching information (difference)	.792	.114	-.068	-.176	.258	-.137
Customer focus/ orientation (difference)	.426	-.014	.798	.174	.022	.004
Drive, initiative and results focus (difference)	.232	.155	.132	.866	.155	-.030
Adaptability and flexibility (difference)	.051	.220	.296	.533	-.402	.081
Self-management and self-motivation (difference)	.787	-.019	.083	.379	.184	.163
Professionalism (difference)	.408	.000	.806	.024	.049	-.046
Interpersonal effectiveness (difference)	.607	-.025	.208	.121	-.482	-.013
Integrity and reliability (difference)	.863	.010	.066	.297	-.076	.168
Reading/writing (difference)	.102	.961	-.030	.115	-.023	.106
Listening/speaking (difference)	.102	.961	-.030	.115	-.023	.106
Mathematics (difference)	-.013	.835	.089	-.117	.150	-.015
Critical and Analytic thinking (difference)	.053	.360	.365	.215	.636	.169
IT skills (difference)	.102	.961	-.030	.115	-.023	.106
Study skills (difference)	.084	.375	.016	-.210	-.034	.797
	% of Variance					
	26.4	19.4	10.8	8.5	7.8	7.4

Plotting PC1 against PC2 (Figure 7.15) seems to indicate a few outliers but no distinct groups and a reasonable spread in both scores. The outliers (3 students) to the right of the plot scored themselves afterwards as 7 across all competencies.

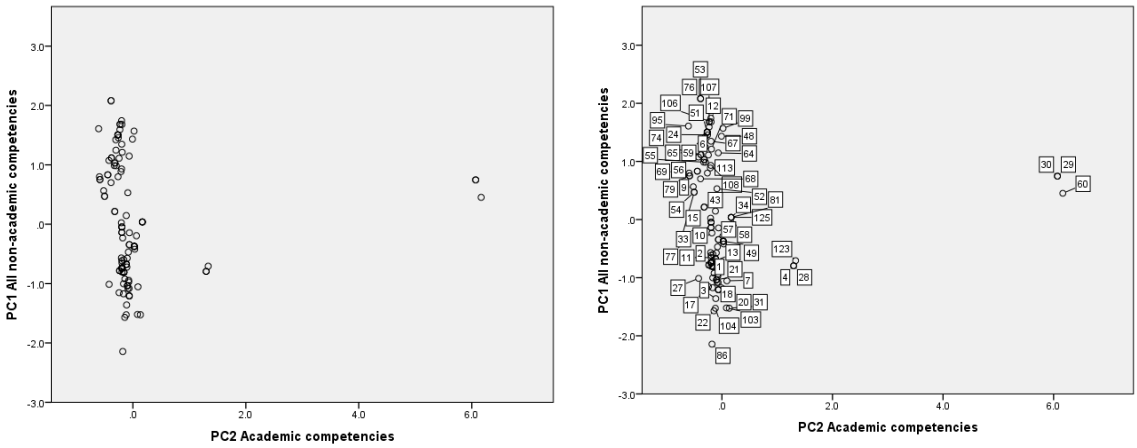


Figure 7.15 Plot PC1 against PC2 for the <u>differences</u> in 'before' and 'after' competencies

7.3.5.5 Discussion of PCA Results

Principal Component Analysis has been useful in the exploratory analysis of the student competency ratings data. Some general points of interest include:

a) Most of the variance in the before competency rating data can be explained by either 3 components (84%) or 4 components (90%), suggesting that the competencies can be adequately expressed in at most 4 dimensions.
b) The Academic competency relating to Mathematics (and also perhaps Study Skills) is perceived as being different from the other academic competencies by many students.
c) The initial identification of 3 categories of competencies, namely Workplace, Personal effectiveness and Academic gives a reasonable grouping of the competencies. However, as noted above, students' ratings of their abilities do not necessarily group exactly in the same way.
d) There are outliers who did not vary their rating across the 20 competencies. It may be that those students who chose ratings at the extremes of the scale (i.e. 2 and 7) may not have fully engaged with the survey at all. However, with only 4 such students, they would not greatly influence our analyses so we chose not to

remove them. Those students who chose consistent ratings throughout of 4, 5 and 6 are considered to have responded in the best way that they could.

e) The identification of 3 groups of students may enable the building of profile descriptions and further refinement of the developmental feedback that can be given to WRL students.

7.3.5 Implications to Final Module Grades

We considered the final module marks for the students who had taken the WRL module; 73 out of 97 of whom completed the module and had achieved a final mark. We fitted a General Linear model to explain the final marks in terms of whether they had received feedback or not. We also considered if there was a gender or degree type effect. Our initial model, where the error is assumed to be normally distributed, can be expressed as:

$$FinalWRLmark = \mu + F + G + D + \text{error}$$

The effects of G and D were not statistically significant (p=0.57, p=0.24 respectively). Considering the reduced model:

$$FinalWRLmark = \mu + F + \text{error}$$

we found that the feedback effect was highly significant (p=0.003). The analysis of variance and table of parameter estimates is given in Appendix E.
The best fitting model has predicted final marks given by:

$$PredictedFinalmark = 59.0 + 8.3 \text{ (if feedback=yes)}$$

Specifically, the average expected final mark for a WRL student who had received feedback is 67.3 whereas the average expected final mark for a WRL student who had not received feedback is 59.0. Also, there is no significant difference between the marks of males and females or between BSc or FDSc students. Thus, it was concluded that on average students who had received feedback had 8.3 marks higher than those who had not.
The P-P plot of residuals (in Appendix F) is reasonably linear, confirming that a linear model with normal errors is acceptable. As an aside, we also tried two transformations, namely sqrt and log, to investigate the feasibility for a potentially more normally distributed model. Appendix F demonstrates that those

transformations do not give any benefit over the initial linear model with normal errors.

We then produced a boxplot to visualise the effect of feedback on final module marks. Figure 7.16 and Table 7.15 show that the marks of those students who did not receive feedback are more spread than those that did. The median for those students receiving feedback is 10 marks higher than those not having received feedback.

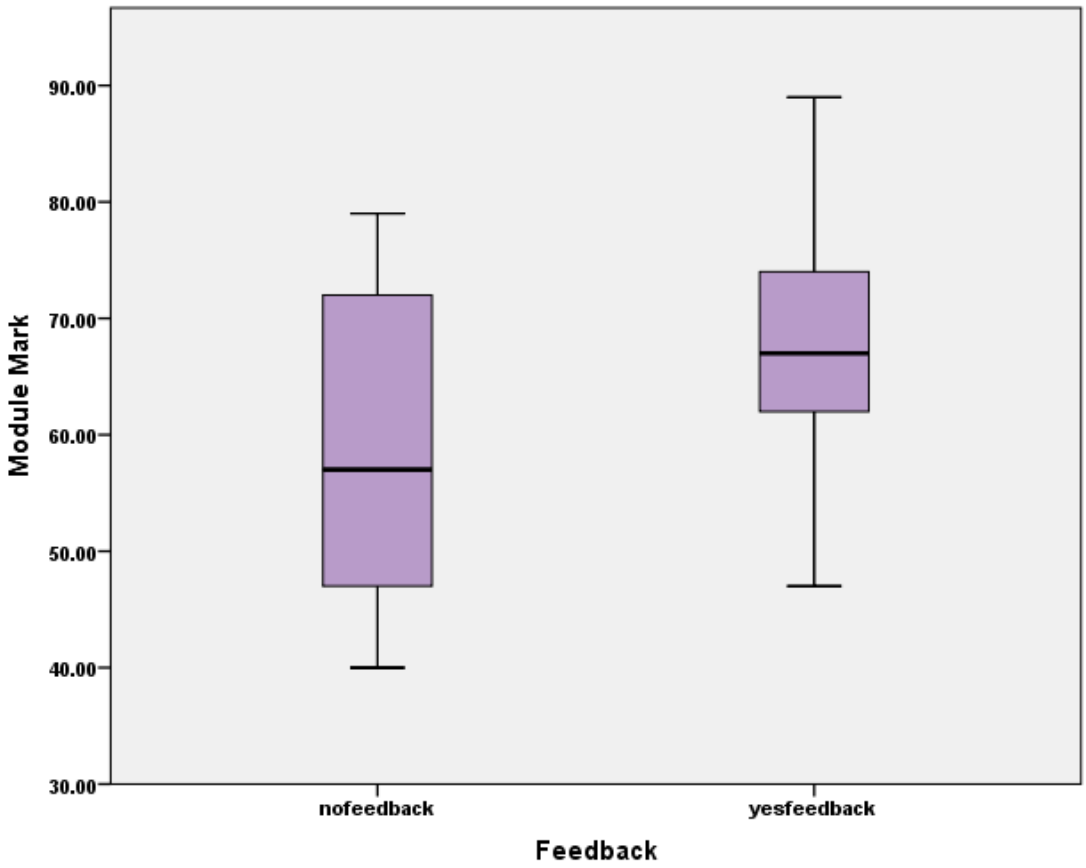


Figure 7.16 Boxplot of Feedback effect on Module Mark

Table 7.15 Descriptive Statistics for the predicted total marks considering feedback

Feedback	Mean	N	Std. Deviation	Median	Minimum	Maximum	Range
nofeedback	59.0	34	12.9	57	40	79	39
yesfeedback	67.3	34	9.4	67	47	89	42
Total	63.2	68	11.9	65.5	40	89	49

7.4 Tracking the Student Sample

As a final part of this data analysis, we attempted to track the 125 students in our sample after they had completed the Work-related learning module and graduated from their course. We were able to gather information about 48 of these individuals and Figure 7.16 shows what they have gone on to do.

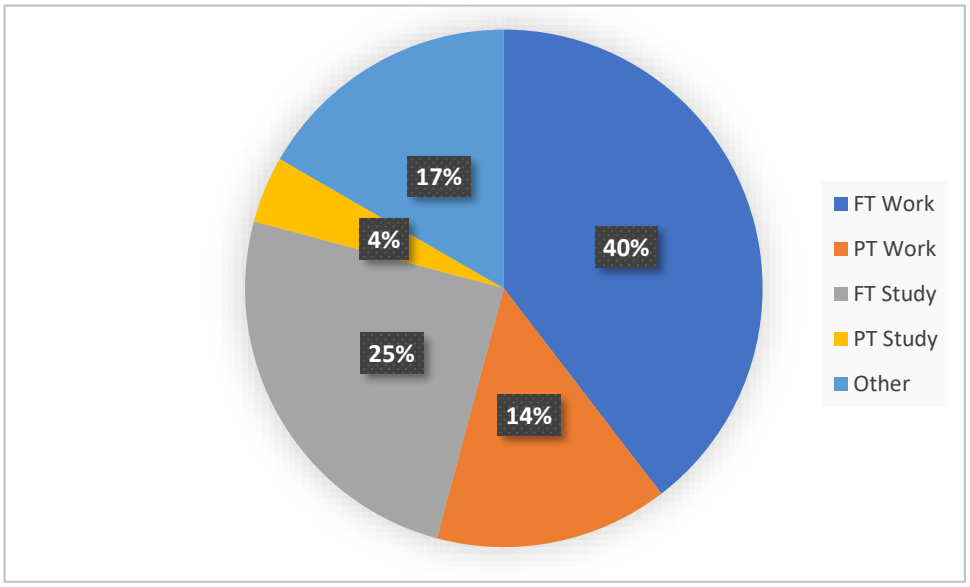


Figure 7.17 Graduate Activity of Student Sample

With these small proportions of data, it is not meaningful to conduct any further analysis of the data. Indeed, no patterns were discerned and we conclude by mentioning that the vast majority of them had experienced some Work-related learning and that 83% of them (from Figure 7.17) are either working or studying, whilst the remaining 17% are 'doing something else', for example travelling.

7.5 Qualitative Analysis

The developmental feedback sessions were the ideal situation in which to capture complex verbal descriptions of how students were experiencing the WRL module and also what individual improvement the feedback was giving them. Whilst the self-evaluative survey provided a means of rating competencies, the feedback sessions allowed for a much broader, and very often much deeper, articulation of student behaviour and perception. The flexibility of qualitative research meant that subsequent feedback sessions could be tailored and customised to individuals.

The first feedback session would normally begin with a discussion of the self-rating scores of the individual student. Subsequent sessions usually centred on a handful of competencies and, where the student was immersed and engaged in the workplace, could often be contextualised to a specific workplace task. Although the developmental dialogues were designed to focus on those competencies for which the student had lowest scores, many students wished to explore the skills they felt more confident about and therefore better able to evidence.

The feedback dialogues and discussions were recorded as notes and were therefore not transcribed. The relatively low volume of commentary did not require the use of computer assisted applications such as NVivo; rather the analysis was based on a personal intuitive interpretation.

The following sections describe and summarise the feedback dialogues and the implications for the cohort and for the individual. Particular comments are not attributed to any individual to ensure anonymity, rather they are included here to give a flavour of the general perceptions and concerns. In most cases the perceptions can be extrapolated to describe the inclinations of the cohort as, even though some individuals were reticent, it was felt that they shared these intuitions.

7.5.1 Understanding of terminology

The majority of students articulated problems with the terminology of competency. Comments of a general nature were made such as ‘the list is long and difficult to

keep track of' and 'I understand workplace and academic – but what are personal effectiveness competencies'. It is clear that many students had not been faced with this style of competency-based activity elsewhere on their course. When asked, the more articulate students were able to describe their knowledge of learning outcomes as something tangible which they need to show on their submitted assessments as achieving. These students also commented that they felt the competency framework was more abstract and more about themselves than any other assessment they had undertaken. One student made this insightful comment: 'Coursework is about how I can code a program or design a sequence diagram – but this is about how I think about how I can do those things'.

Most students appeared to find clarification in the developmental feedback cues and the webpage allowed them to access the competency they needed clarifying.

7.5.2 Stumbling blocks

The majority of students could not explain the particular competency of 'Professionalism', with the weaker students finding this concept difficult to grasp even after discussion. Many students assumed that this competency was about dress codes and punctuality. However, when discussions progressed to other aspects of professionalism, such as being flexible, maintaining confidentiality of information, fitting into the cultural norms of the organisation, interacting with others respectfully, students were able to begin thinking of ways to put professionalism into practice in the workplace.

A discussion with a mature student revolved around an individual's self-perception and 'being professional to yourself', by which this student meant a certain approach to working. This particular discussion was also around how to learn to be professional and whether students could be taught this competency. This perceptive mature student believed that all students should be passionate about their studies, respectful to their peers and tutors, take pride in their submitted work and come prepared to classes – these being some ways in which to practice the competency of professionalism as a student.

7.5.3 Pairing and merging of competencies

Several students asked for further clarification on the difference between some of the competencies. A predominant question was 'What is the difference between business fundamentals/commercial awareness and customer focus/orientation?'. Students tended to want to discuss prior experiences of jobs in the retail sector and often spoke about customer satisfaction as being the same as 'knowing the business'. Useful discussions which helped some students to differentiate and acknowledge that commercial awareness was a more broader skill than just ensuring that a client's immediate needs were being met.

Another question that students asked was 'How is fundamental IT skills different to working with tools and technology?'. This blurring may have occurred because this group of students were all on a Computing-related degree and so by definition, they probably possessed a higher than average proficiency of basic and generic IT skills. Those students who had being exposed to new technologies, in the form of customised software development platforms for example, in the workplace had a much better understanding of the difference between IT skills and working with other technologies. We return to this particular issue in Chapter 8, where a case can be made for subsuming these two competencies.

7.5.4 Thoughts on self-evaluation

When students were asked about their experience of completing the self-evaluation form, there was consensus that this was a difficult and often painful activity. Sample comments were: 'I find it really difficult', 'I don't like doing it', 'I tried to be as honest as possible', '…was tempted to always rate myself highly'. One student made a positive comment: '…built up my confidence in myself. …found I could talk about my strengths and weaknesses'. Whilst another student notes that 'It's nice not to be graded by a tutor all the time'.

When students were asked whether they preferred self-rating, peer-rating and transparency, they replied 'I wouldn't like my peers to see it' and 'I would not like

my friends to rate me' as well as '…please don't show my scores to anyone in the class'.

7.5.5 Usefulness of participation

Overall, students found the activity useful. One final year student 'would have liked it earlier in their course' and another student liked the 'the aspect of personal effectiveness [as there was] not much scope in the course to do that'. Many students agreed that the developmental feedback sessions 'built up my confidence'. Although two students did report that they '…couldn't see the benefit of it'. Several students felt that the self-rating opportunity showed them where their strengths were and also where they needed to get more experience and practice. Many students felt that the opportunity to talk about themselves in a non-assessed, non-interview and face-to-face environment was helpful; as it provided them a mechanism for articulating their strengths and deficiencies.

When asked what one thing stood out for them, several students pinpointed a particular competency (although the actual competency citied varied amongst the students) as being the most important thing they had found about which they had not thought about previously. Students also indicated that whereas they were unfamiliar with some of the competency terms beforehand, they felt much more informed about them afterwards. One articulate student went further to say that '…..I know about the competencies but now I appreciate how important it is to be able to find ways of evidencing them and practicing them'.

7.5.6 Difference between WRL and non-WRL students

The developmental feedback sessions were markedly different between those students who were taking the WRL module and those who were not. The WRL students' sessions tended to be lengthier, more detailed and focussed on discussions of particular competencies in relation to a workplace task. For example, one such student found the development feedback cues for the competency of 'planning, organisation and prioritising' useful for organising weekly workloads with the use of a custom scheduling tool that he shared with his manager. Another such student

saw improvement in their 'business fundamentals/commercial awareness' competency when he followed the developmental feedback cue of carrying out an investigation of the (voluntary) organisation's 'competitors' and independently producing an analytical research-style report for the manager without being asked to.

Non-WRL students, on the other hand, tended to simply ask for further clarifications of competencies and discussions were oriented around hypothetical workplace scenarios which could not be readily put into practice, although some students did try to relate aspects to their existing part-time workplace in the leisure, retail or entertainment industries.

7.5.7 Focus Group

At the end of the WRL module, a small focus group comprising of two students from each of the categories was undertaken:

- WRL module and developmental feedback
- WRL module but no developmental feedback
- No WRL module and developmental feedback
- No WRL module and no developmental feedback

This exercise provided the opportunity to elicit further opinions from the widest possible audience in the sense that it encompassed not just those who had received developmental feedback (whose opinions are exemplified in the preceding sections) but also those who had not participated in the developmental feedback sessions. The activity was intended to be informal and spontaneous but the moderator (myself) did engage the group with a set of pre-determined, open ended questions such as:

What does Work-related learning mean to you?
What benefit(s) did you gain from the WRL module?
How do you feel about the inclusion of this module within your degree? Should it be compulsory?
In what ways did the developmental feedback help you?
How did you feel during the development feedback sessions?
What did you think about the self-evaluation form?

Did you use any competency understanding in other modules?
Which competency is the hardest for students to become proficient at? Why?

The session had a particularly positive ambience as the participants were very amiable and keen. Recurring themes and comments mirrored much of the above individuals' commentary. Whenever someone in the group mentioned something, all group members agreed verbally or nodded.

The non-WRL module students commented that they might have liked to have that module on their programme and those who did not receive any developmental feedback wished they had.
A significant proportion of the time was spent on a discussion around the competency list – specifically related to students' inability to attempt to master/understand/reflect so many competencies.

7.6 Summary

The quantitative and qualitative data analysis conducted in this chapter has shown that Work-related learning together with developmental feedback can have a positive effect on students' experiences, leading to an enhanced awareness of the requirements of the workplace. The self-rating form, administered both at the beginning and end of the semester, appears to be an effective opportunity for students to measure their own perceptions. This 'measuring' opportunity is a sound, practical self-evaluative option for all students regardless of whether they are in a WRL experience or not.

8. Optimising the Competency Framework

8.1 Introduction

A recurring factor during interactions with students in the sample was that they experienced difficulties when attempting to address all the 20 competencies in a relatively short span of time. Having established in the previous chapter that students can be grouped according to their scores and also that variability in scoring can be explained by 2 or 3 principal components, we now proceed to carry out further investigation into the competency framework and consider how competencies are connected to each other. Our aim is to segment and potentially (re)categorise the competencies so that student experience initiatives can be better targeted.

Popular statistical tools for data analysis which focus on investigating the relationships between variables are cluster analysis and correlation analysis. The cluster analysis of **variables** uses the Euclidean *distance* between the scores on the variables to determine which variables are close to each other. In terms of our competency framework, clustering will allow us to determine the degree of association between the scoring of competencies across all 125 students. The correlation matrix of variables uses correlations, essentially normalised sum of cross products of scores on pairs of variables. In terms of our competency framework, correlations will give us an alternative measure to allow us to highlight those competencies which are strongly related to each other. Cluster and correlation analysis are similar but different measures of the closeness of the association between variables.

Our aim is to utilise both these measures, in a way that has not been performed on competency frameworks previously, to give us two ways of understanding how competencies are perceived.

8.2 Hierarchical cluster analysis using dendograms

We carried out a hierarchical cluster analysis of the 20 competency variables. In order to understand this better and to visualise the cluster analysis of the variables, a dendogram was generated which displays the distance level at which there are combinations of clusters. Figure 8.1 is the SPSS derived output in its raw format, with the 20 'before' competencies labelled in abbreviated form on the y-axis, which shows that there are indeed strong groupings of variables.

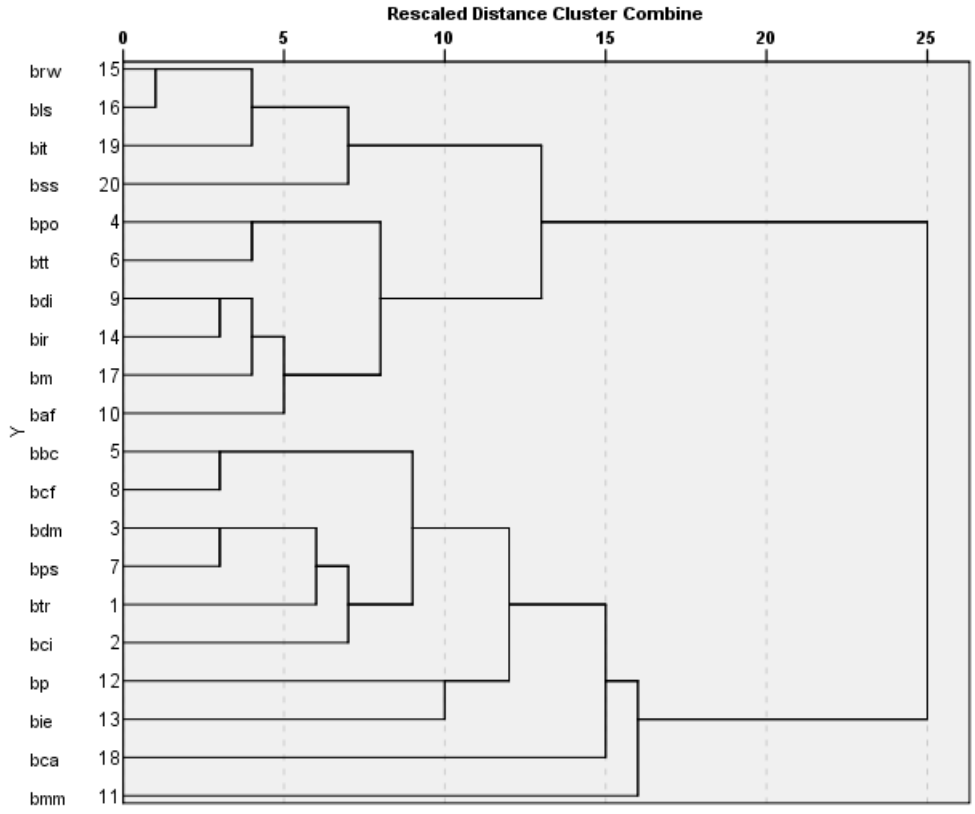


Figure 8.1 SPSS Dendogram of 'before' competencies

It is possible to consider these groupings at various levels, at one extreme (towards the right of the diagram) we have two cluster groups and at the other extreme (towards the left of the diagram) we could view the majority of competencies as being either clustered in pairs or singular.

There are many 'levels' in between these two extremes. For instance, at Level A (Figure 8.2 annotated in red), the groupings broadly correspond to our original three categories of Academic, Workplace and Personal effectiveness, with four additional 'singleton' competencies. Strikingly, some competencies stand out as not

being closely related to others, e.g. 'professionalism', 'interpersonal effectiveness', 'self-management and self-motivation'. The competency of 'critical and analytic thinking' also does not have similar student scores to most other competencies. During discussion, the students did appear to find this competency difficult to relate to and contextualise; with some students preferring to link it to 'mathematics'.

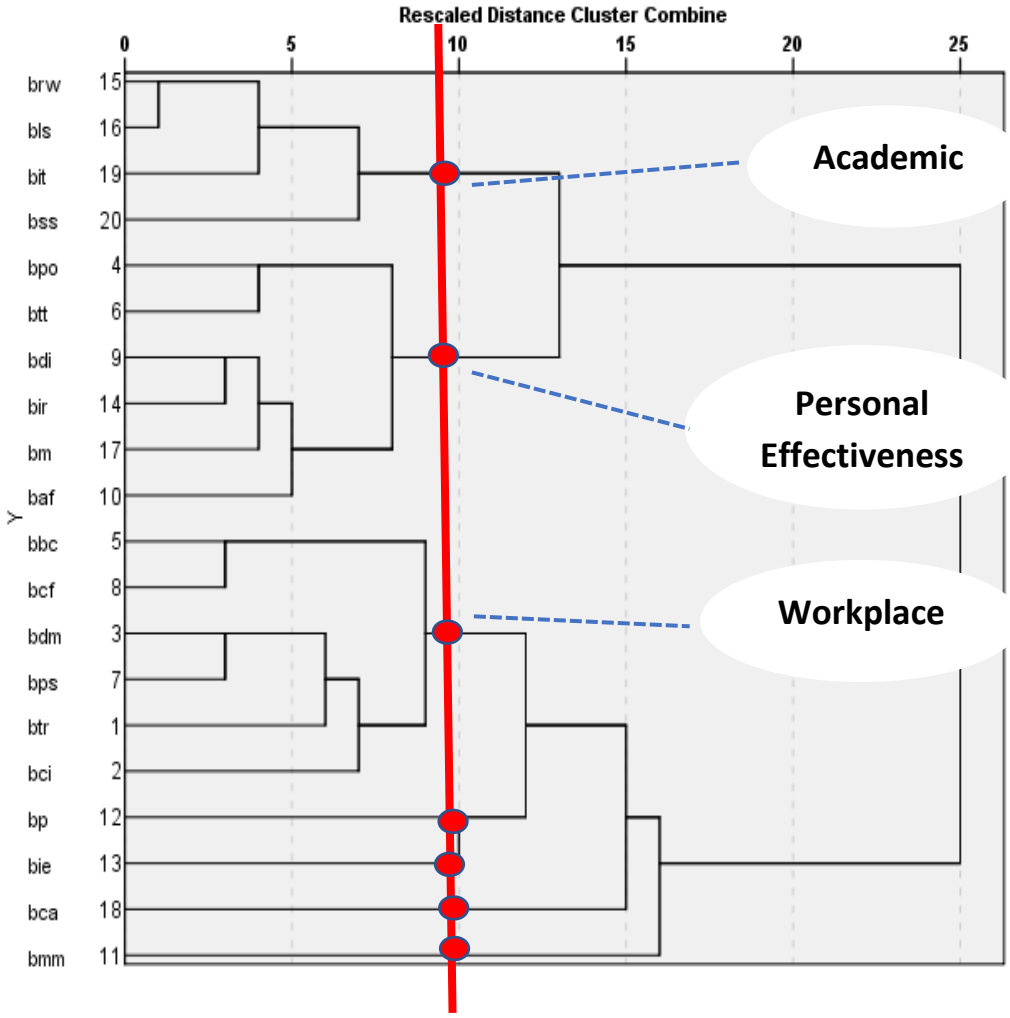


Figure 8.2 Annotated Dendogram of 'before' competencies at Level A

Another way of exploring the dendogram is at Level B (Figure 8.3 annotated in green), which is a finer-grained approach in which the competencies fall into 13 possible connections. The groupings at Level B are indicated as:

- [[reading/writing, listening/speaking], fundamental IT skills]
- [study skills]
- [planning, organisation and prioritising, working with tools and technology]
- [[drive, initiative and results focus, integrity and reliability], mathematics]
- [adaptability and flexibility]

- [business fundamental/commercial awareness, customer focus]
- [decision making and judgement, problem-solving and researching information]
- [teamwork and relationship building]
- [creative and innovative thinking]
- [professionalism]
- [interpersonal effectiveness]
- [critical and analytic thinking]
- [self-management and self-motivation]

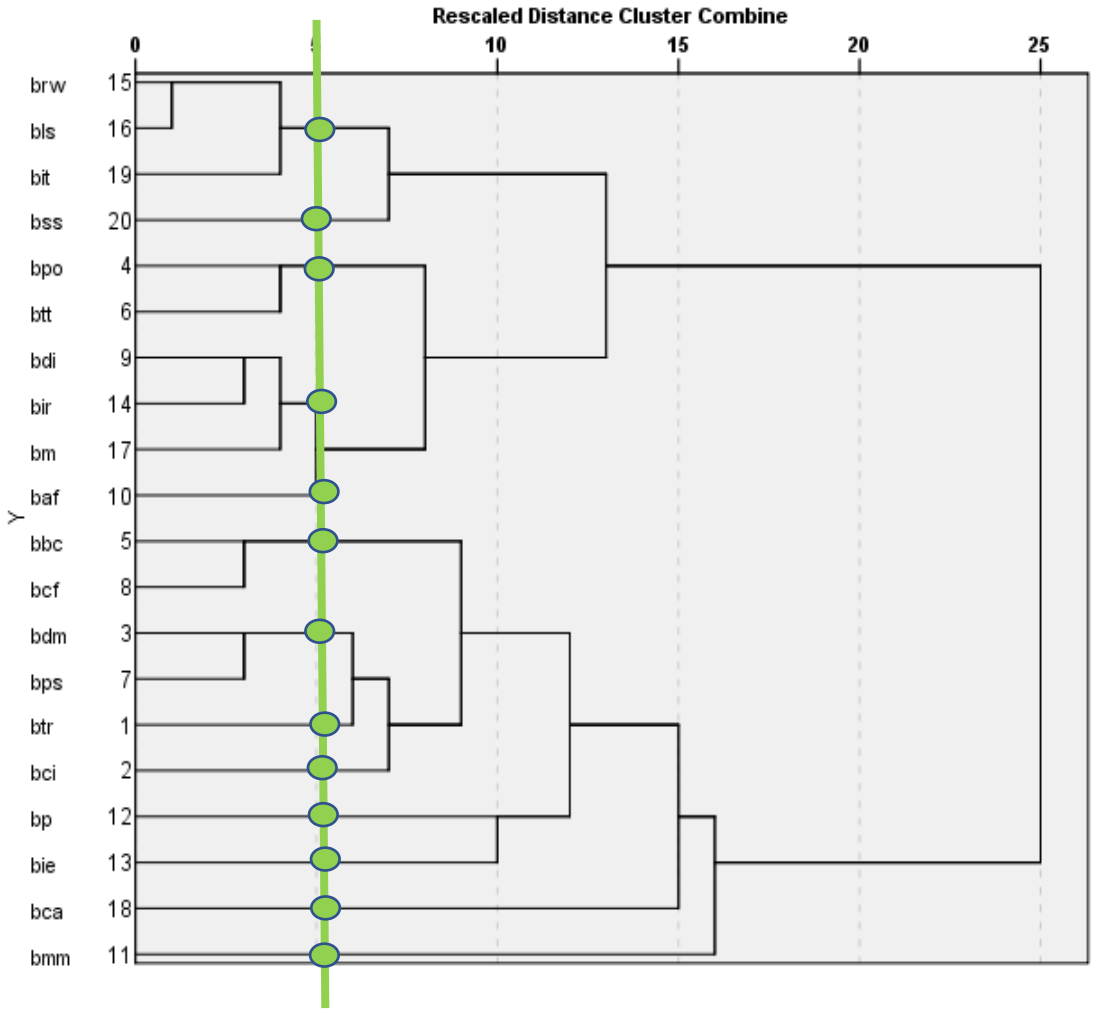


Figure 8.3 Annotated Dendogram of 'before' competencies at Level B

A final possible view of the dendogram is shown in Figure 8.4 where we assume an even finer-grained level (Level C, coloured in blue) in which a total of 16 competencies can be abstracted as being grouped together.

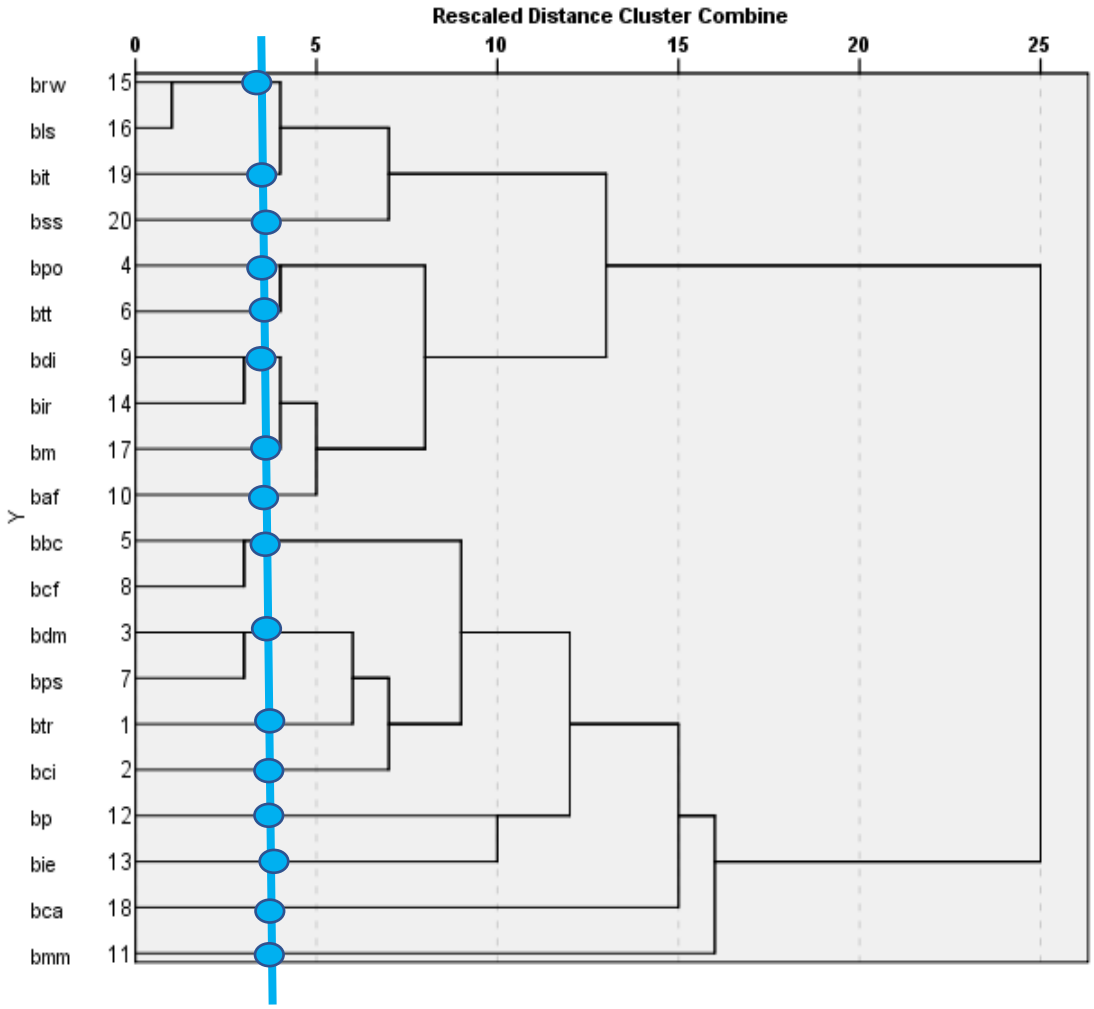


Figure 8.4 Annotated Dendogram of 'before' competencies at Level C

The clustering dendograms illustrate the correlations structure of the way students regard the relationships between the various competencies, indicating a general consistency of responses within the 3 competency groupings as depicted in Figure 8.2. However, the clusters of variables that seem most balanced and pragmatic are those that can be viewed in Figure 8.3 in which we could envisage the pairing (or grouping into 3) of competencies, such as considering 'business fundamentals/commercial awareness' and 'customer focus/orientation' as being paired. Some competencies, such as 'professionalism', 'interpersonal effectiveness', 'self-management and self-motivation', appear not to be 'pairable' in this sense and are possibly best considered as individual competencies.

In summary, the cluster analysis of prior competency scoring indicates some strong groupings of the variables within our 3 competency headings, confirming that the students often give similar scores to competency questions prior to their starting the module. However, the prior module competency scores on some variables are not closely related to those of other members of their competency group, indicating that these variables are in some way seen as different by students. Thus, while it would appear that there is some redundancy in the some of the before module questions (as responses are closely related), there are some competencies that benefit from separate questions.

On the basis that

1) We have established that variable responses are indeed clustered and therefore there is potential for eliminating redundancy,

2) There is scope for optimising the groupings whilst still preserving the variability of competencies,

3) Students might respond more successfully to fewer targets,

we now proceed to the use of correlation analysis as a further tool to aid in the refinement of the competency framework.

8.3 Correlation Analysis using Correlation Matrix

The competency framework has 20 competency questions, arranged under 3 main headings, (i) Workplace competencies (8 questions), (ii) Personal Effectiveness competencies (6 questions) and (iii) Academic competencies (6 questions).
Many of the 20 competencies were expected, a priori, to be highly correlated. Indeed, as remarked earlier in 7.3.1, the values of Cronbach's alpha for the before and after competencies were 0.96 and 0.97 respectively, as would be expected from highly correlated competencies. In fact, when we produced the correlation matrix in Table 8.1 (summarised from the full competency matrix in Appendix G), many of the 190 correlations were indeed large and positive. Table 8.1 shows that some 28 of these correlations were greater than 0.8 (i.e. within a 95% confidence interval of an

exact correlation of 1.0), indicating that these pairs are measuring much the same thing in the eyes of the students. Moreover, many of the eight Workplace competencies were highly correlated, giving confidence that they were indeed measuring the same inherent competencies useful in the work environment. Thus, it might be deemed desirable to redefine these questions to incorporate the essence of both members of the pair, thereby reducing the number of competency questions.

8.3.1 Reducing Highly Correlated Variables

Dimensionality reduction is a process by which the number of variables or dimensions is systematically removed for modelling purposes. This process is useful in our case because for the student responses to the 20 competencies there are many of the 190 correlations that are strong. It is therefore possible to consider reducing the number of variables without greatly losing information. The process relies on the generation of a correlation matrix and the aim here is to find the most representative variables from pairs of highly correlated variables and discarding the 'redundant' or less correlated variables.

We produced the correlation matrix and considered the amalgamation, or replacement, or preservation of competencies both from a pairwise approach and from a more wider perspective of sets of competencies. We have confidence in this process where the correlations are above 0.8 (see Appendix H for rationale). Inspecting Table 8.2 and first considering the most highly correlated pair of variables (r=0.982), namely 'reading and writing' and 'listening and speaking', we amalgamated them into a new 'interpersonal communication' skill. Next, we considered the pair with the next highest correlation (0.929), namely 'business fundamentals/commercial awareness' and 'customer focus/orientation', we amalgamated these into a 'commercial awareness' competency. We carried on considering variables in decreasing order of strength of correlation.

Some dominant observations:

Considering Table 8.2, the Workplace competencies (in green) are very highly correlated amongst themselves, so that there is a strong case of merging and consolidating (and where necessary relabelling) them.

Again, from Table 8.2, in the Personal effectiveness category (in blue), many of the competencies do not feature in this list as they do not correlate strongly to each other, and the remainder only correlate with some of the competencies in the other two categories. Importantly, the competencies of 'professionalism', 'self-management and self-motivation' and 'interpersonal effectiveness' do not correlate to any other competency.

In the Academic category (in orange), there is very little correlation between pairs of these competencies and those in the other two categories. Also, the competencies of 'fundamental IT skills' and 'study skills' do not appear in Table 8.2 as they are not correlated to any other competency.

Table 8.1 Correlation Matrix of 'before' competency scores

	Btr	Bci	Bdm	Bpo	Bbc	Btt	Bps	Bcf	Bdi	Baf	Bmm	Bp	Bie	Bir	Brw	Bls	Bm	Bca	Bit	Bss
Btr	1	.829**	.847**	.674**	.727**	.501**	.811**	.827**	.768**	.739**	.669**	.716**	.759**	.723**	.562**	.525**	.569**	.642**	.444**	.417**
Bci	*	1	.742**	.645**	.733**	.640**	.851**	.812**	.727**	.836**	.637**	.733**	.768**	.717**	.373**	.364**	.649**	.449**	.297**	.218*
Bdm			1	.803**	.839**	.596**	.897**	.826**	.748**	.708**	.824**	.699**	.549**	.629**	.431**	.392**	.485**	.486**	.203*	.477**
Bpo				1	.821**	.849**	.828**	.772**	.792**	.702**	.750**	.462**	.379**	.677**	.316**	.279**	.603**	.245**	.260**	.334**
Bbc					1	.729**	.827**	.929**	.702**	.789**	.787**	.675**	.571**	.654**	.185*	.135	.580**	.291**	.134	.241**
Btt						1	.747**	.677**	.691**	.723**	.552**	.339**	.361**	.663**	.221*	.233**	.665**	.078	.347**	.181*
Bps							1	.819**	.794**	.780**	.752**	.725**	.629**	.677**	.391**	.397**	.597**	.431**	.242**	.364**
Bcf								1	.795**	.849**	.672**	.729**	.759**	.763**	.292**	.245**	.679**	.431**	.297**	.160
Bdi									1	.839**	.602**	.567**	.608**	.855**	.589**	.551**	.854**	.584**	.509**	.315**
Baf										1	.652**	.701**	.761**	.858**	.327**	.300**	.840**	.358**	.390**	.135
Bmm											1	.669**	.348**	.513**	.320**	.276**	.399**	.357**	.035	.578**
Bp												1	.755**	.593**	.332**	.328**	.430**	.572**	.177*	.277**
Bie													1	.730**	.359**	.354**	.614**	.482**	.480**	.003
Bir														1	.600**	.552**	.840**	.511**	.648**	.237**
Brw															1	.982**	.457**	.868**	.784**	.744**
Bls																1	.418**	.846**	.794**	.730**
Bm																	1	.411**	.545**	.091
Bca																		1	.594**	.643**
Bit																			1	.361**
Bss																				1

Table 8.2 Correlated pairs of 'before' competencies

Step	Factor	Paired correlations	
1	.982	Reading/writing	Listening/speaking
2	.929	Business fundamentals commercial awareness	Customer focus/orientation
3	.897	Decision making and judgement	Problem solving and researching information
4	.868	Reading/writing	Critical and analytic thinking
5	.858	Adaptability and flexibility	Integrity and reliability
6	.855	Drive initiative and results focus	Integrity and reliability
7	.854	Drive initiative and results focus	Mathematics
8	.851	Creative and innovative thinking	Problem solving and researching information
9	.849	Planning, organisation and prioritising	Working with tools/technology
10	.849	Customer focus/orientation	Adaptability and flexibility
11	.847	Teamwork and relationship building	Decision making and judgement
12	.846	Listening/speaking	Critical and analytic thinking
13	.840	Adaptability and flexibility	Mathematics
14	.840	Integrity and reliability	Mathematics
15	.839	Decision making and judgement	Business fundamentals/ commercial awareness
16	.839	Drive initiative and results focus	Adaptability and flexibility
17	.836	Creative and innovative thinking	Adaptability and flexibility
18	.829	Teamwork and relationship building	Creative and innovative thinking
19	.828	Planning, organisation and prioritising	Problem solving and researching information
20	.827	Business fundamentals/commercial awareness	Problem solving and researching information
21	.827	Teamwork and relationship building	Customer focus/orientation
22	.826	Decision making and judgement	Customer focus/orientation
23	.824	Decision making and judgement	Self-management and self-motivation
24	.821	Planning, organisation and prioritising	Business fundamentals/ commercial awareness
25	.819	Problem solving and researching information	Customer focus/orientation
26	.812	Creative and innovative thinking	Customer focus/orientation
27	.811	Teamwork and relationship building	Problem solving and researching information
28	.803	Decision making and judgement	Planning, organisation and prioritising

Figure 8.5 includes an indication of how the process of amalgamation proceeded with some relabelling of competencies. As can be seen from the diagram, some unification took place by reducing a pair of highly correlated variables into a single one with some relabelling based on student comments in feedback sessions and educator judgement. Four of the original competencies, namely 'professionalism', 'study skills', 'interpersonal effectiveness' and 'IT skills' did not appear in the highly correlated variable list as being above the correlation threshold of 0.8 and are therefore depicted separately to the right most side of the figure and included as they are in the final set of competencies.

The optimisation process has been performed by knowledge of domain, human/educator judgement and variable correlation analysis. It has been possible to synthesise some of the terminology of competency. Some judgement was used when amalgamating competencies, particularly for the Workplace competencies as they were extremely interlinked with each other and featured repeatedly in the correlation list.

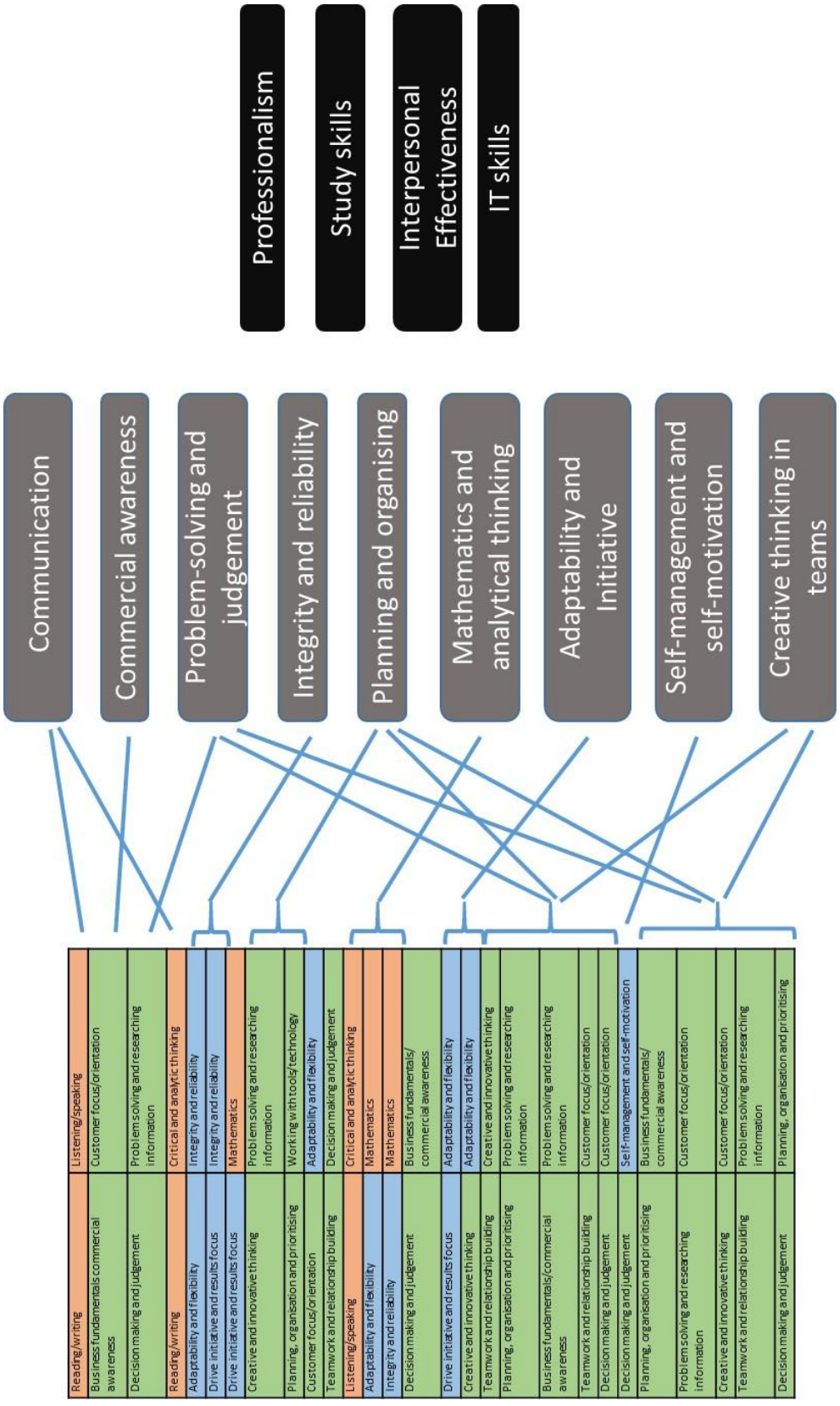


Figure 8.5 Optimising the 'before' competencies

8.4 Comparison of Cluster and Correlation Outputs

We have made use of cluster and correlation analysis in a novel way to investigate the way in which competencies are perceived by students. We can conclude from both types of analysis that the original 20 competencies can indeed be crystallised into a smaller subset of tightly bound competencies which can capture the perceptions of students regarding their proficiency.

As expected, there is much convergence in the outputs of the analyses, Figure 8.6 shows our preferred cluster analysis output, namely Figure 8.3 and the output arrived at from the correlation analysis, namely Figure 8.5, side-by-side.

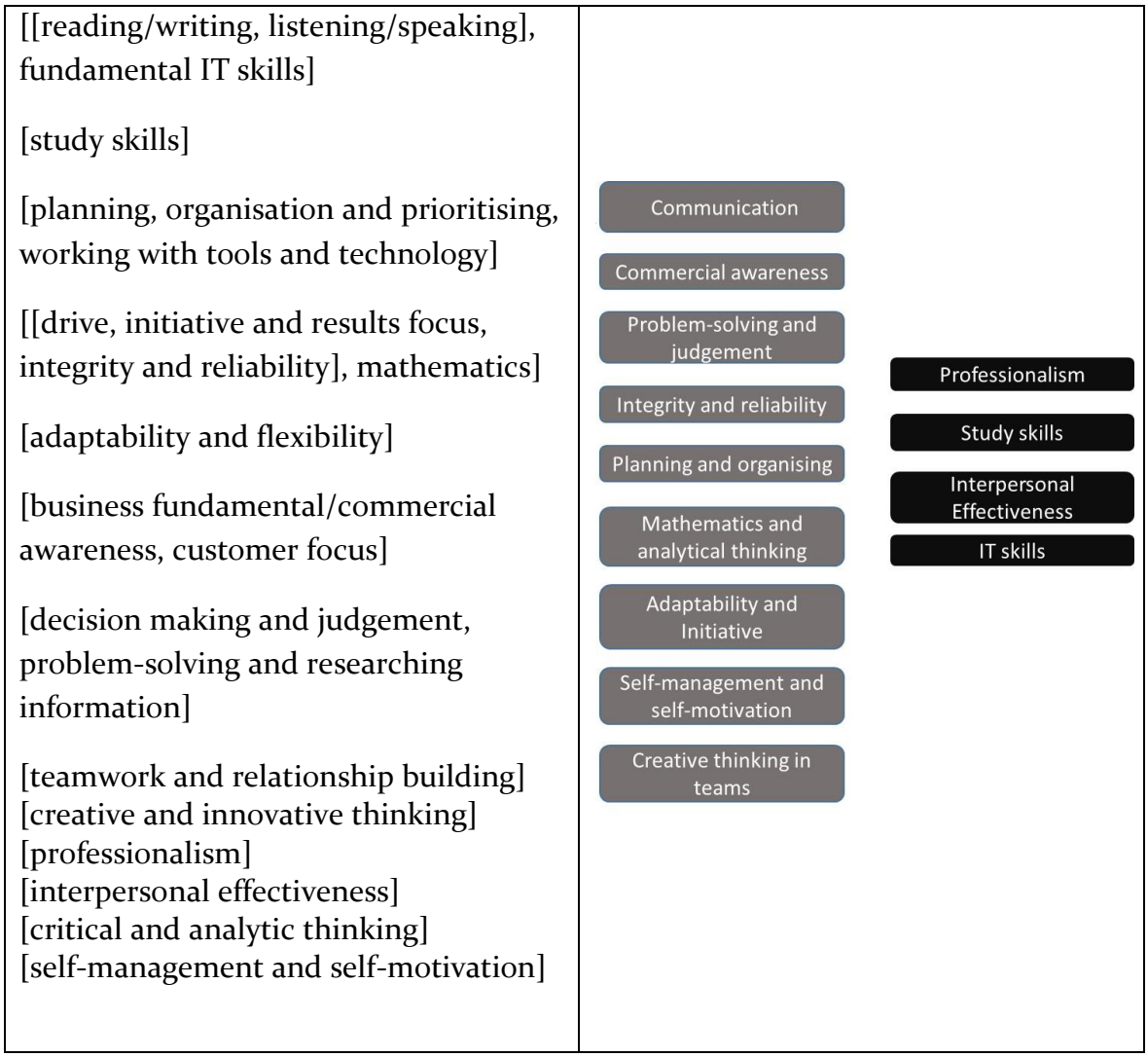


Figure 8.6 Results of cluster and correlation analysis

8.4.1 Optimising the Competency Framework

The opportunity to optimise the competency framework arises from the results of cluster and correlation analysis in which we were able to observe a tight network of correlations. An important aim of the optimisation process is to ensure that the competency framework is minimal, contains no overlap, is comprehensive as possible and yet there is to be no loss of explanatory power. A judicious approach was used in the distillation process where in one or two instances there was a choice of what to include and how to label it. Educator judgement and experience as well as student commentary during developmental feedback sessions helped in these circumstances.

From Figure 8.6, we are confident that 13 competencies at most are required to express the explanatory power of the 20 original competencies. There are very minor differences in the outputs from clustering and correlating; we therefore accept the labelling as now shown in the final optimised competency framework (Figure 8.7), in which we have been able to preserve the original 3 groupings of competencies, namely Workplace, Personal Effectiveness and Academic.

Both the Workplace and Academic competency categories have undergone a substantial change in terms of the reduced number of competencies (from 8 to 4 and from 6 to 4 respectively). Interestingly, the Personal effectiveness category is still made up of broadly the same competencies as previously, meaning that student perceptions of them are more distinct. Specifically, in the Personal effectiveness category only two of the competencies, 'drive, initiative and results focus' and 'adaptability and flexibility' have been consolidated to become 'adaptability and initiative'. The remaining four competencies have all been preserved. This leads us to the conclusion that Personal effectiveness competencies are all pervasive and contribute to the wellbeing of an individual in both academic and workplace environments. These competencies play a vital role in an individual's capacity to 'perform'.

We have achieved a tighter Workplace category centreing on business acumen and solution-driven characteristics, giving students an opportunity to sharpen their perception of the needs of the workplace.

We have also been able to condense the Academic category so that prominence is now given to study and IT skills. For the students in this sample, as they are on Computing-related degrees, the original 'fundamental IT skills' competency was seen to be closely related to 'working with tools and technology' and therefore no separation between them was made. However, if the competency framework was to be used generically to include all types of disciplines, then the 'fundamental' aspect may need to be reconsidered.

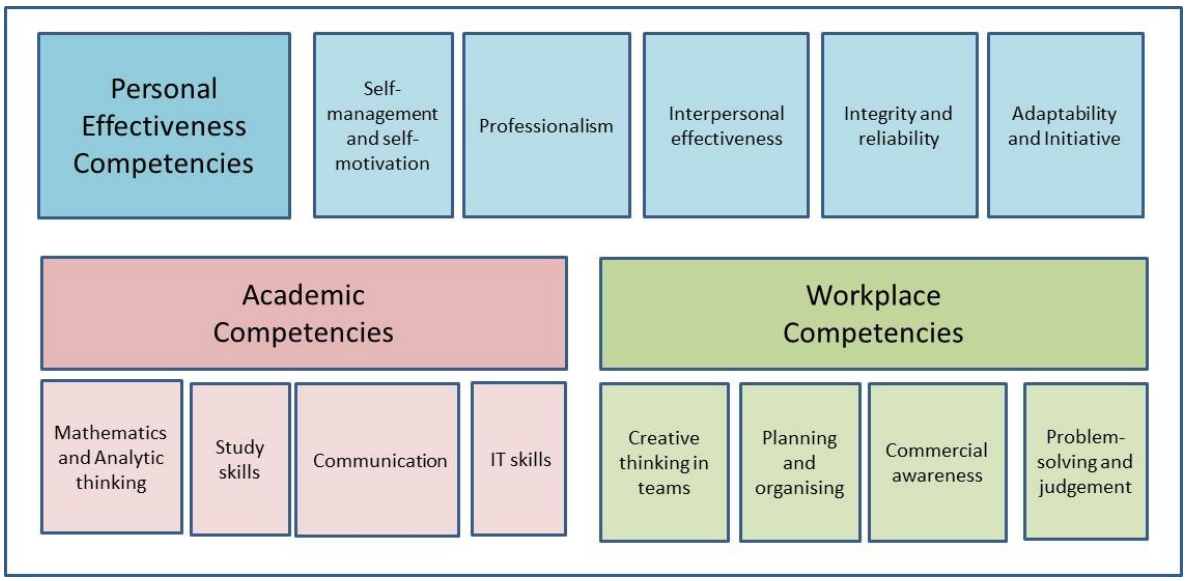


Figure 8.6 Optimised Competency Framework for Work-Related Learning

8.5 Discussion of Cluster and Correlation Analysis Results

Cluster and correlation analysis has been useful in the investigation of competency scoring relationships. Some general points of interest include:

a) The three original categories seem sensible and are useful to maintain; but we found much scope within each category to reconfigure and reduce.
b) The reduction of correlated variables has allowed us to distil the 13 most important competencies. This is advantageous as students could now be exposed to a condensed version of the competency framework in the first

place. In addition, assessments can be tailored to measure the improvement of these specific thirteen skills.

c) Within the optimised competency framework, competencies are now broadly orthogonal to encapsulate the importance of each one.
d) Both types of analysis have shown that there are a handful of skills (related to personal effectiveness) that stand apart from each other and were therefore not highly correlated. These appear to be the competencies that many students would struggle to understand, practice and evidence. Developmental feedback in these areas could prove to be particularly beneficial, as it is during the course of the WRL experience that students may be able grapple with them in some grounded context.

8.6 Summary

We have been able to show, in the first instance, that students' scoring of their competency perceptions tend to be clustered around particular competencies. If the students are regarding and responding to competencies in a highly-clustered way, then there may be some redundancy and the cluster analysis shows several ways that the groups of competencies could potentially be viewed. Next, we were able to investigate the way in which competency scores were correlated, which led to a fruitful distillation of the original twenty competencies down to just thirteen. We have, therefore, been able to eliminate randomness and focus on a clear pattern of highly significant competencies. The resulting optimised competency framework is a strong, simplified and highly usable tool which features personal effectiveness competencies heavily.

9. Discussion

9.1 Introduction

The preceding chapters have detailed the development, use and analysis of a strategy to enable students to refine and improve their understanding of competency building. In this chapter, we consider some broader issues that this research work may impact as well as how those issues may impact our work. In particular, we discuss the trending changes in HEI provision such as developing self-skills, degree apprenticeships, competency-based education, measuring graduate skills, digital credentials, DLHE statistics and NSS.

9.2 Self skills

Understanding the competencies that need to be mastered in order to achieve their goals is a primary requirement for students. Our competency framework is an enabler of this understanding, as it allows students to see what they have mastered, what they still need to accomplish, and exactly which competencies they need to further improve. The framework also gives students opportunities to take ownership of their own development in a self-regulating way, thereby strengthening a sense of personal identity.

Interestingly, the optimisation of the original competency framework in Chapter 8 resulted in the majority of the Personal effectiveness competencies remaining intact, meaning that student perceptions of them are more distinct. This leads us to the conclusion that Personal effectiveness competencies are all pervasive and contribute to the wellbeing of an individual in both academic and workplace environments. These competencies play a vital role in an individual's capacity to 'perform'. Whilst, it may be viewed that the Workplace competencies are the ones to be addressed by a Work-related learning experience, we believe that actually this is an ideal chance to consider, improve and feedback on the Personal effectiveness competencies – something which assessments on 'taught modules' cannot do effectively.

These insights can contribute to the redesign of parts of the undergraduate curriculum in which the development of Personal effectiveness skills can be focussed upon and where tutor feedback can be given.

The literature review in Chapter 2 revealed a large number of studies and initiatives encouraging various forms of peer-evaluation. Our strategy though is targeted at self-review and self-improvement.

9.3 Developmental Feedback

Our strategy utilises developmental feedback to make real gains to the improvement of students' perceptions of their skill levels. We have found that developmental feedback is the most appropriate type of feedback during Work-related learning as it can empower students by helping them to identify weaknesses or gaps and can reinforce their role in enabling changes. This type of feedback ties in particularly well with our aim of making students aware of, and also supporting them to make improvements in, self-skills.

Challenging students to make the best use of developmental feedback cues (which in this case is aided by the self-use of the web tool) allows them to reflect on a set (or subset) of competencies which are required to be applied to workplace tasks. This challenge is an effective endeavour as it can have lost lasting benefit beyond a student's academic programme.

9.4 Competency-based Education

Virtually all organisations recognise the important role that competencies play in building organisational culture, building capability and improving individual and team performance. As a result, organisations routinely employ core competency framework tools to support the identification of knowledge/skill gaps, the prioritisation of learning and development needs, and the consistency of a common format for all organisational departments. As students are destined to enter this environment, some timely exposure can provide opportunities to make informed

career decisions and more importantly can assist by highlighting behavioural evidence of how the individual has met certain work-related objectives.

Current HE curriculum design attempts to differentiate and personalise learning to serve individual students or categories of students. As such, shifts towards learner-centric education which are pragmatically driven by social and economic pressures tend to feature competency-based learning heavily. The three key characteristics citied by the Blackboard blog[11]: learner-centricity, outcomes-based and differentiation yield benefits to students, academics, policy makers and other stakeholders. These benefits include: improved student retention and completion rates, acknowledgement of prior learning, goal-aligned assessments and outcomes-based improvements to courses.

Whilst competency-based education encompasses a brought spectrum of curriculum (with the possibility of entire competency-based Diplomas of Higher Education), within this research work we have focussed on the provision of competency-based developmental feedback on a small and finite set of core competencies targeted specifically for use within a Work-related learning experience. Therefore, we see our work as an approach to Competency-based education which aims to specifically improve the ability of:

- Students to identify, manage and enhance their competencies by more precisely being able to identify strengths and weaknesses during a workplace experience.
- Employers to understand students' generic competencies and achievements in learning and the application of that learning before they enter the employment market upon graduation.

[11] Blackboard blog http://blog.blackboard.com/

9.5 Degree Apprenticeships

An alternative education route launched in 2015, the degree apprenticeship, allows the simultaneous benefits of higher level study together with on-the-job training. Degree apprenticeships have employability at their core and aim to equip an individual with a breadth of learning and experience that allows them to adapt to changes in employer demands and the job market. This type of degree has substantial training, with long duration periods in the workplace interspersed with intensive study blocks.

Our strategy and tools can have a significant part to play in the degree apprenticeship arena by supporting the continual cross-over between workplace and study. The competency framework can be the central secure point at which the stakeholders (employers, academics and students) can return throughout the programme to measure improvements and performance.

9.6 Digital Credentials

Competency and skills recognition can come in many guises and several learning institutions have adopted digital badges to represent the acquisition of skills by the successful badge-holder. With Mozilla's[12] Open Badge platform gaining momentum aided by support from the IMS Global Learning Consortium[13], there is now a standardised open source environment in which the digital badge concept can be deployed. Since digital badges can motivate, inspire and sustain students throughout a programme of study, resulting in gains in retention and overall performance, some HEIs are keen to explore their use. However, the fundamental disadvantages of authenticity, validity and trustworthiness are barriers too significant to ignore.

An aspect of digital badges that we believe could be an interesting addition to our work is the focus on building evidence and creating artefacts which represent

[12] The Mozilla Foundation www.mozilla.org

[13] IMS Global Learning Consortium www.imsglobal.org

student competencies. Students, particularly such as those Computing students in our study, do struggle with evidencing their competencies in ways which can be readily recognised by employers. In the context of work-related learning, the potential ability of digital badges to capture the complete learning path and the ability to 'travel' with the student beyond graduation coupled with their ability to signal achievement to potential employers are important advantages. Digital badges can also play a significant role in developing an online academic and professional identity for students/graduates, allowing portable evidence of competency achievement of learning and application.

9.7 Measuring Graduate Skills

The term 'graduate skills' is not easily definable, and yet it is pertinent to HE outcomes, graduates and employers alike. Indeed, there appears to be a disconnect in the measurement of graduate skills in that there is little clarity or consistency. Adding to the mix is that DLHE[14] and TEF[15] refer to 'highly skilled' graduates and 'highly skilled' employment outcomes. The answer to the question "what are the special attributes that successful completion of an HE course gives" is not clear. The skills or attributes that a graduate is purported to have are precisely the skills that employers seek. Rich (2014) puts forward an interesting proposal for the measurement of graduate skills based on a concise set of skills which are graded on a nine-point scale. Rich (2014) advocates the use of a chart to describe the skills that any course of study develops. Also advocated is that the same chart is used by employers to describe those skills that are necessary for particular job roles. Figure 8.1 (reproduced entirely from Rich (2014)) shows an example of the chart for two sample courses and for two sample job roles.

[14] Destination of Leavers from Higher Education annual survey of new graduates.
[15] Teaching Excellence Framework, 2016.

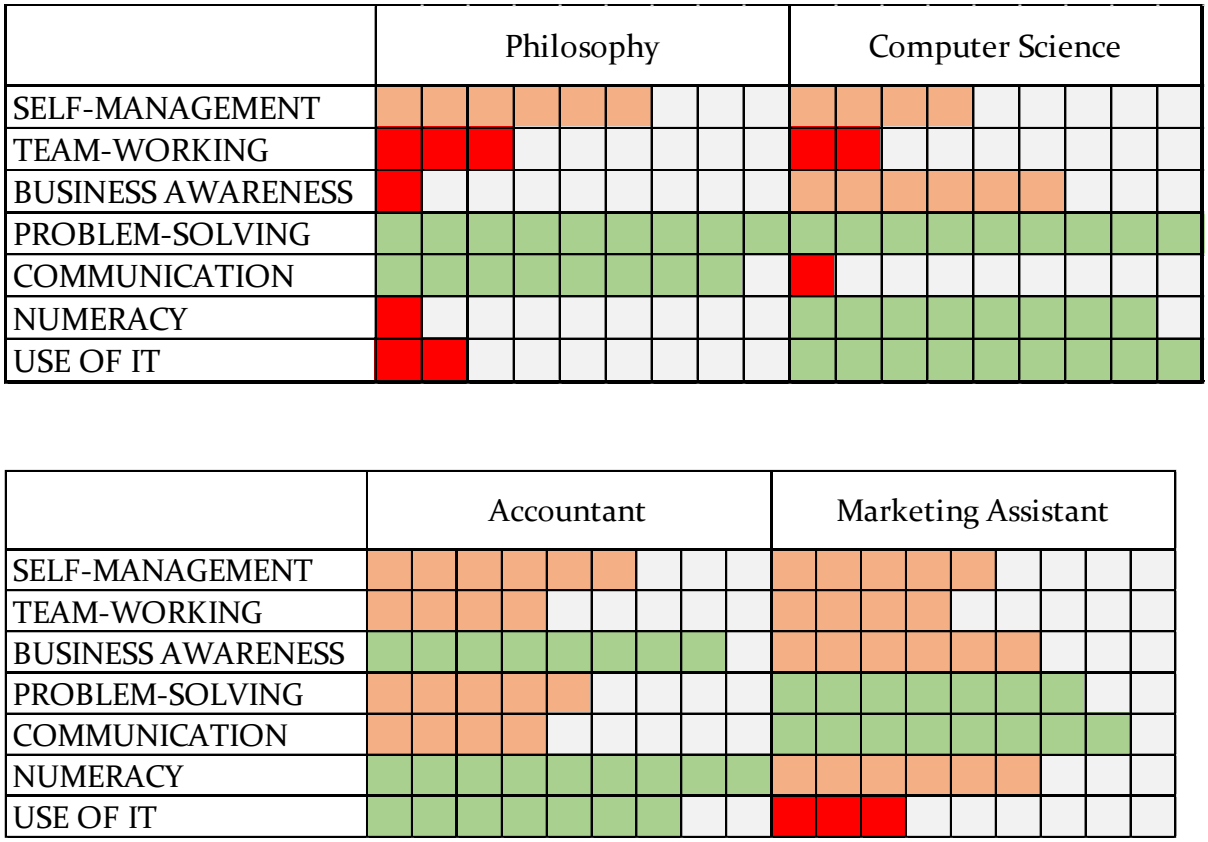


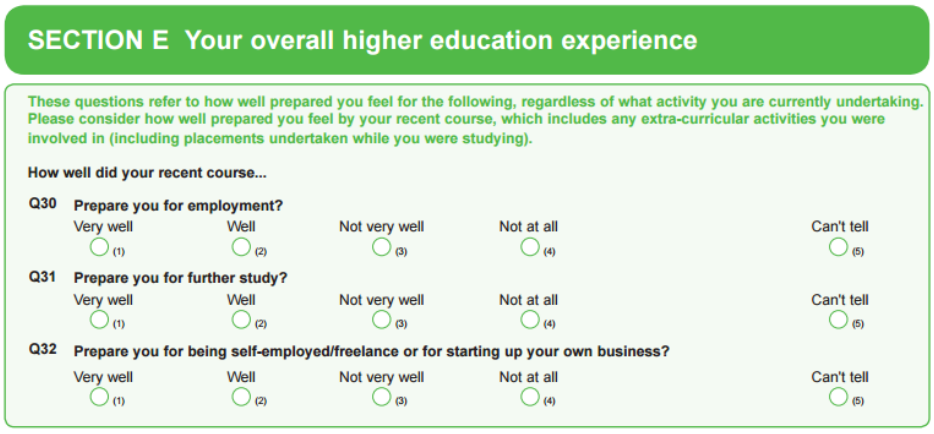
Figure 9.1 Example of Graduate Skills Chart

Further, in a report which considers HE outcomes (Birkin et al, (2014)), there is a suggestion that the circle can be fully completed if the chart was used to represent 'the skills that graduates have attained on leaving higher education'. The report also states the value of 'a universal system that is simple and reliable, and which offers a way to recognise the value of what HE offers to students beyond the instrumental knowledge specific to a particular course or career'.

Exactly which skills are to be used in such a scheme is debatable and Rich (2014) applies, arbitrarily, a set of 'transferable' skills used by the National Union of Students (NUS) that are the seven shown in Figure 9.1. However, we believe that the thirteen competencies resulting from our optimised competency framework give a more comprehensive approach as they have been arrived at from a distillation of student perceptions and that these perceptions are individualistic rather than for an entire cohort of subject.

9.8 Destination of Leavers from Higher Education (DLHE)

The annual DLHE survey aims to establish what new graduates are doing six months after graduating, specifically whether they are employed, undertaking further study, travelling or caring. Higher education courses are geared towards graduates gaining employment and therefore this would be measured within the survey. Graduate cohorts from courses which have embedded Work-related learning initiatives would therefore presumably have a higher percentage of graduates in employment. The survey consists of 32 questions (although this may increase as a result of the current review) of which Q30, as shown in Figure 9.2, is the one that is of interest to us. The Higher Education Academy (HEA)[16] suggests that "We need to do more to embed employability within the curriculum, and to support recording of the skills and aptitudes gained, so that students develop and demonstrate the qualities and characteristics employers are looking for in graduates." Our competency framework goes some way to allowing the 'recording of the skills and aptitudes gained'.



SECTION E Your overall higher education experience

These questions refer to how well prepared you feel for the following, regardless of what activity you are currently undertaking. Please consider how well prepared you feel by your recent course, which includes any extra-curricular activities you were involved in (including placements undertaken while you were studying).

How well did your recent course...

Q30 Prepare you for employment?

Very well	Well	Not very well	Not at all	Can't tell
(1)	(2)	(3)	(4)	(5)

Q31 Prepare you for further study?

Very well	Well	Not very well	Not at all	Can't tell
(1)	(2)	(3)	(4)	(5)

Q32 Prepare you for being self-employed/freelance or for starting up your own business?

Very well	Well	Not very well	Not at all	Can't tell
(1)	(2)	(3)	(4)	(5)

Figure 9.2 Excerpt of DLHE Survey, January 2017 – Section E

Work on revising the DLHE survey is moving forward, with HEI consultation during 2016, and an area which is open for debate is whether a skills-based approach in a

[16] Dr Mark Jones, COO of the Higher Education Academy (HEA), commenting on the DLHE statistics published in June 2016 for the preceding year's cohort.

future survey of graduates is feasible and/or desirable. We believe that where students have had some prior exposure to determining the level of their skills, as with our competency framework, it is more likely that they will be better placed to answer questions based on skills acquisition in such a survey in the future.

We also believe that the self-reflective aspects of our strategy, along with the entire HE experience, could also help to develop students' personal effectiveness skills well beyond graduation so that they are able to respond positively to the longitudinal DLHE that is used 3.5 years after graduation.

9.9 Employable or Employability

The differentiation of the terms 'employable' and 'employability' is an interesting factor to consider against the backdrop of modern aspirations of career development where individuals expect to have multiple occupations throughout their careers. Very few students wish for a specific job, but all students want to achieve, and expect to achieve from a degree, a high level of employability by developing skills and competencies that can increase their chances of getting a good (not necessarily well-paid) job that is useful and can make a contribution to society. Contemporary graduates do not necessarily desire employment in a specific job role but are more concerned with improving their employability prospects, possibly including entrepreneurial skills, and widening their career options in general. Therefore, within our competency framework we did not focus on the job role competencies as such, since these are in any case very specific. Rather, we concentrated on the Workplace, Personal effectiveness and Academic competency categories as they can be improved more generally to provide more clarity in the competencies needed to complement key professional/technical skills of particular job roles.

In addition, our competency framework needs to be usable by students from any subject discipline and therefore a focus on 'occupation-specific' skills are secondary to other, more generic, skills. These occupation-specific skills are arguably better considered and improved when an individual is in a particular job role, where

professional sector-specific, role-specific and task-specific competency frameworks are in use.

9.10 National Student Survey (NSS) – Personal Development

The annual National Student Survey administered to students in their final year of a higher education course, previously contained a section with three questions related to personal development. Table 9.1 gives a summary of the scores for HEIs and FECs over a 3-year period. Interestingly, part-time students studying at an HEI appear to be less satisfied with their development, so there is obviously some work to do here. Our interventional strategy, with its focus on development of competencies particularly those in the Personal effectiveness category, could shed some light.

Table 9.1 Summary of NSS results for Questions 19,20 and 21

	2013 f/t		2013 p/t		2014 f/t		2014 p/t		2015 f/t		2015 p/t	
Question	**HEI**	**FEC**	**HEI**	**FEC**	**HEI**	**FEC**	**HEI**	**FEC**	**HEI**	**FEC**	**HEI**	**FEC**
Personal development												
19 - The course has helped me present myself with confidence.	81	81	77	84	81	82	75	84	82	82	75	82
20 - My communication skills have improved.	84	82	75	81	85	83	74	81	86	83	73	80
21 - As a result of the course, I feel confident in tackling unfamiliar problems.	82	80	77	82	82	81	76	83	83	81	75	80

*Statistics shown only for England

The newly revised survey (for use in 2017)[17] has undergone several changes, with several new sections being added. Unfortunately, the Personal development section has been entirely removed and not replaced with anything related to surveying the personal developmental outcomes of students. This makes a case for trying different methods of investigating student satisfaction in this area. Our developmental strategy, which highlights personal effectiveness during Work-related learning, could also help educators to record, gauge and gain insights into how students are perceiving their own development.

[17] HEFCE Circular letter 30/2016: A new National Student Survey for 2017 includes Annex A: Final list of NSS 2017 question
http://www.hefce.ac.uk/pubs/Year/2016/CL,302016/

9.11 Student profile

The profile of a student, in terms of demographics (age, gender, ethnicity), social class, educational background, financial status, mode of study, marital status and care responsibilities are important factors when developing competencies. In particular, Black and Minority Ethnic (BME) students, with limited social capital, typically experience greater challenges when striving to enhance their level of employability. We believe our developmental strategy can assist BME students to practice the art of self-reflection and self-regulation in a sheltered environment. Access to activities, such as work experience, extra-curricular pursuits and wider-ranging cultural experiences, which are known to boost employability may be limited for BME students. An embedded Work-related learning with opportunities for development of competencies and self-management may assist this particular group of students. Part-time students, particularly those that find their HE course less personally developmental (Table 9.1), may also be assisted by a strategy which focusses on competency building.

9.12 Summary

In this chapter, we have discussed various areas that relate to our research work and have presented multiple contexts in which our interventional developmental and competency-based strategy has potential use. The HEI employment outcomes agenda requires institutions to adequately prepare graduating students to enter the highly competitive job market with as much (self) awareness of what will be required of them as possible.

10. Conclusions

10.1 Introduction

As the Higher Education sector evolves to address those economic and social factors that constitute a 'value for money' provision, the past decade has seen the fortifying of employability skills acquisition into academic programmes in all subject disciplines. On the one hand, the priority placed by students on developing generic, transferable and work-related skills as an integral part of their academic study in order to enhance their employment prospects has never been higher. On the other hand, employers continue voicing their strong concerns over graduates who are lacking necessary problem-solving, business communication and personal management skills required in the workplace. These dual demands have been responded to by the HE sector with the introduction and embedding of several Work-related learning initiatives into the academic curriculum.

In this research, we have pinpointed and further developed three main pedagogical aspects that together make a powerful combination to support Work-related learning initiatives, namely: an optimised competency framework suitable for use in academia, a set of developmental feedback cues and opportunities for the improvement and practice of self-skills by students.

We arrived at improvements in students' employment outcomes by firstly conducting a thorough review of current feedback practices which led to the development of a taxonomy of feedback. This taxonomy, which when evaluated against a set of dimensions to verify its robustness, gave further insights into the manner in which students perceive feedback. Recurring common themes around the most effective types of feedback centred on self-regulated learning, with much agreement in the literature that where such developmental and personalised feedback is made available, the chances of students being able to self-regulate themselves and genuinely assimilate and apply the feedback is much higher. We acknowledged that self-regulation is not an easy learning skill to acquire as it

requires meta-cognitive awareness, autonomy, strategic action in the form of planning, monitoring and evaluation, and above all else a motivation to learn. Developmental, continuous feedback cycles, as well as future-altering concepts appeared to be the categories of feedback that could yield the most long-term benefits for students. We have shown that developmental feedback which relates directly to a professional competency is arguably the most effective feedback that a Work-related learning student can receive as it opens up the possibilities for target-setting, skills development, self-management, and preparation for professional employment.

The taxonomy evaluation also highlighted the area of experiential learning in general and the Work-related learning area in particular, where further attention of feedback provision was required. As competency-building was seen to be important and valuable for students and with a view that this could be best achieved during a Work-related learning experience, the research set about to develop a concise competency framework adapted from a number of large (often mammoth) professional frameworks.

We were able to refine and optimise the original competency framework in a way which has not been done previously, with the use of cluster and correlation analysis by understanding how students self-rate themselves against the various competencies. The optimised competency framework is a strong, simplified and highly usable tool which can provide insights for curriculum design and careers guidance.

Together, the optimised competency framework, the developmental feedback cues and self-regulatory exercises, make a novel and powerful combination with which to enhance the benefits from a Work-related learning experience. This combination has allowed us to put forward a strategy for improving the employment outcomes of graduates. Our work has enabled students' own understanding of competencies and

confidence in them has been enhanced by Work-related learning and developmental feedback. The module marks and employability have also been improved.

This research impacts:

- **Curriculum design** with the confirmation that embedded and compulsory Work-related learning initiatives can yield benefits,
- **Students** by exposing them to much needed self -regulating and self-reflecting opportunities focussed on improvements in competencies required in the workplace,
- **New graduates** by exposing them to the practicing and evidencing of competencies in preparation for, and for use in, the workplace.
- **Academic tutors** by furnishing them with a set of tools to conduct developmental feedback sessions,
- **Employers** by helping them to differentiate amongst the high volume of new graduates entering the employment market.
- **HEI policy makers** that are mindful of the need to improve employability outcomes and thereby gain better results in the National schemes that measure institutions on their ability to produce graduates who can gain relevant graduate-level employment.

10.2 Research Objectives Met

The overall aim of this research was to use existing and current feedback practices and professional competency frameworks in more adapted, specific ways and investigate their use on work-related learning by considering the optimal ways in which the employment outcomes of students on an academic programme can be enhanced.

Therefore, the main research objectives met are:

- An extensive and critical review of current feedback practices.
- A new contribution to knowledge through the development and evaluation of a taxonomy of feedback practices in order to identify predominant, underutilised and hybrid forms.
- An exploration of professional competency frameworks to assess their suitability for use on an academic programme.
- A new contribution to knowledge through the development, implementation and evaluation of a set of intervention tools, including a competency framework, developmental feedback cues and self-evaluation methods, to inform a strategy for the improvement of student employment outcomes.
- The application of a wide range of statistical and modelling techniques, including general linear modelling, cluster analysis, principle component analysis and correlation analysis to interpret the data findings, and more importantly for optimisation purposes.
- To propose a practical strategy which powerfully combines a range of tools for improving the employment outcomes of students.

10.3 Contribution of the Research

This research has specifically extended existing knowledge in four main ways by:

5) Identifying an underutilised area of feedback practice through the development and evaluation of a new taxonomy of feedback.
6) Identifying the most effective forms of feedback and demonstrating the power of combining feedback practices to enhance student experience and performance.
7) Arriving at an optimised competency framework with the use of numerous statistical and modelling techniques.
8) Developing a strategy to enable students to refine and improve their understanding of competency building.

10.4 Limitations of the Research

Frameworks, particularly those related to competencies, can, by their very nature, be viewed as being subjective. This may explain the vast number of professional competency frameworks that are currently available in all sectors and specialist sub-sectors of industry. Indeed, our optimised competency framework is the result of the synthesis of knowledge of domain, human/educator judgement and experience, cluster/correlation analysis and student commentary. Although an important aim of the optimisation process was to ensure that the competency framework should be minimal, contain no overlap and yet be as comprehensive as possible, there is a small degree of arbitrariness or subjectivity in the distillation process.

Self-rating schemes can be used by participants incorrectly with under or over generous ratings. Students in particular are accustomed to being continuously assessed and when asked to self-rate, may behave in a manner that is not true to themselves. This, in fact, is even more reason to seek ways to expose them to the practice of self-regulation and self-reflection.

10.5 Future Work

A number of potential avenues of future work emerge from the findings of this research:

Wider dissemination. The optimised competency framework developed in Chapter 8 consolidates the main competencies that undergraduate Computing students could focus and improve upon. Future research could allow students following academic programmes with an embedded Work-related learning component from a variety of subject disciplines, particularly humanities, to be exposed to the optimised competency framework with a view to achieving similar improvements in those students' perceptions and competency-building abilities. A more voluminous longitudinal study which tracks students from the very beginning of their journey through to successful employment could prove useful.

Professional Bodies and Societies. The optimised competency framework could undergo further analysis under the scrutiny of chosen professional bodies towards the development of student workplace competencies that is usable by HEIs, thereby helping to bridge the gap that currently exists between new graduates, who are typically not adept at the language of competency, and fluent professionals.

Statistical Modelling. Further interesting work could be conducted to build upon the analysis performed here with the use of item-response theory (IRT) model by the use of extensions of Rasch modelling techniques. This type of analysis could help to improve student-rating accuracy further by highlighting the predominant discriminative competencies. IRT could therefore yield further insights into student behaviours and allow for some form of prediction.

Web Tool Development. The basic developmental tool built here could be further developed to encompass features such as an area for the recording of self-reflective notes. The tool could eventually be used for the creation of entire employability portfolios, complete with tangible evidence, which students could take to the employment market.

In conclusion, we have put forward a practical strategy for the application of developmental feedback and self-regulative opportunities for use within a Work-related learning experience with the aid of an optimised competency framework.

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Chapter 2

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Appendix A Scoping Study Survey

Using your Work Related Learning module experience

About improving your skills

1 / 2 50%

1. How would you rate the overall usefulness of the Work Related Learning module?
Please complete this question whatever work you are currently doing.

	Extremely useful	Very useful	Not very useful	Not at all useful
To your degree	◯	◯	◯	◯
To your job search	◯	◯	◯	◯
To your current work tasks	◯	◯	◯	◯

2. During your Work Related Learning module you will have been trying to improve skills for employment.
The following questions relate to skills which employers look for and which you could have improved during WRL.

How would you rate your effectiveness at these skills BEFORE the WRL module?

	Extremely good	Very good	Good	Not very good	Not good
Communication & Interpersonal	◯	◯	◯	◯	◯
Teamwork skills	◯	◯	◯	◯	◯
Initiative & Problem-solving skills	◯	◯	◯	◯	◯
Organisation & Time Management skills	◯	◯	◯	◯	◯
Professional Conduct skills	◯	◯	◯	◯	◯
Information Technology skills	◯	◯	◯	◯	◯

3. How would you rate your effectiveness at these skills AFTER the WRL module?

	Extremely good	Very good	Good	Not very good	Not good
Communication & Interpersonal	◯	◯	◯	◯	◯
Teamwork skills	◯	◯	◯	◯	◯
Initiative & Problem-solving skills	◯	◯	◯	◯	◯
Organisation & Time Management skills	◯	◯	◯	◯	◯
Professional Conduct skills	◯	◯	◯	◯	◯

4. How would you rate your effectiveness at these skills NOW?

	Extremely good	Very good	Good	Not very good	Not good
Communication & Interpersonal	◯	◯	◯	◯	◯
Teamwork skills	◯	◯	◯	◯	◯
Initiative & Problem-solving skills	◯	◯	◯	◯	◯
Organisation & Time Management skills	◯	◯	◯	◯	◯
Professional Conduct skills	◯	◯	◯	◯	◯
Information Technology skills	◯	◯	◯	◯	◯

Next

Using your Work Related Learning module experience

About getting useful feedback

2 / 2 100%

5. You were assessed on the WRL module by a weekly learning log, a portfolio/report and a presentation.

What type of feedback were you given on these assessments?
Please give as much detail as you can.

6. How happy were you with the feedback you received?

Extremely happy	Very happy	Happy	Not very happy	Not happy
○	○	○	○	○

7. Which feedback has helped you most in your tasks at work? Please rank 1 to 6.

- Feedback on my Communication & Interpersonal skills
- Feedback on my Teamwork skills
- Feedback on my Initiative & Problem solving skills
- Feedback on my Organisation and Time Management skills
- Feedback on my Professional Conduct skills
- Feedback on my Information Technology skills

8. Did you have a chance to reflect on this feedback at the end of the module?

Yes	No	Not sure what this means
○	○	○

9. Have you reflected on your experience of the WRL module now that you are working?

Yes	No	Not sure what this means
○	○	○

10. How do you normally like to be given feedback? Choose one or more.

- ☐ Short comments on my work
- ☐ Detailed comments on my work
- ☐ Verbally
- ☐ In a group
- ☐ As a mark or grade

Prev Done

Appendix B List of English Words Prefixed by 'Self'

From www.wiktionary.org Note: Due to the nature of this collaboratively edited site the content can be added/removed over time.

A
self-absorption
self-abuse
self-acceptance
self-action
self-adhesive
self-advancement
self-advocacy
self-affinity
self-affliction
self-analysis
self-annihilate
self-appointed
self-assembled
self-assembly
self-assurance
self-assured
self-authenticating
self-aware
self-awareness
B
self-belief
self-blood
self-built
C
self-complacent
self-conceit
self-condensation
self-confidence
self-confident
self-congratulate
self-congratulation
self-conjugate
self-conscious
self-consciousness
self-contained
self-contradictory
self-control
self-controlled
self-conviction
self-correct
self-coup
self-critical
self-culture
D
self-deceit
self-deception
self-declared
self-defense
self-delusion
self-denial
self-deprecating
self-destruct
self-destruction
self-destructive
self-determination
self-devotion
self-discipline
self-distance
self-distributive
self-doubt
E
self-educated
self-effacement
self-effacing
self-employment
self-energy
self-esteem
self-evidence
self-evident
self-evidently
self-evolution
self-exam
self-examination
self-excitation
self-excitation
self-exclusion
self-existent
self-explanatory
self-expression
F
self-fertile
self-fertilization
self-flattery
self-fulfilling
H
self-hardening
self-harm
self-hateful
self-hatred
self-help
I
self-identify
self-image
self-immolate
self-immolation
self-importance
self-important
self-imposed
self-improvement
self-incrimination
self-induction
self-indulgence
self-indulgent
self-injective

self-interest
self-involved

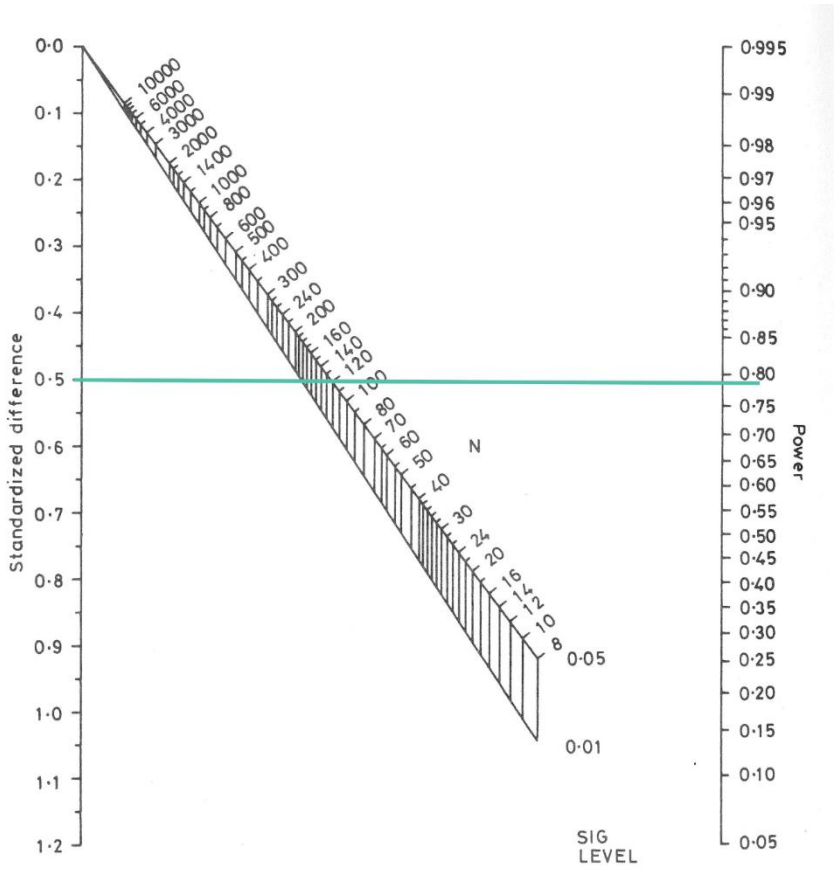
J
self-justification
self-justificatory
K
self-kill
self-knowing
self-knowledge
L
self-licensing
self-love
M
self-made
self-mastery
self-motivated
self-murderer
N
self-narrative
O
self-opinion
self-organization
P
self-perpetuating
self-perpetuation
self-pity
self-pleasing
self-pleasure
self-pollinating
self-pollination
self-pollute
self-portrait
self-possession
self-praise
self-presentation
self-preservation
self-pride
self-proclaimed
self-promotion
self-protection
self-publishing
Q
self-quenching
R
self-realization
self-redress
self-reference
self-referential
self-refutation
self-regulated
self-reliance
self-reliant
self-repellency
self-respect
self-restraint
self-righteous
self-righteously
self-righteousness
S
self-sabotage
self-sacrifice
selfsame
self-satisfaction
self-satisfied
self-secure
self-secure
self-seed
self-seeker
self-selection
self-name
self-similarity
self-slaughter
self-slaughter
self-soar
self-standing
self-starter
self-sterile
self-striping
self-styled
self-suck
self-sufficiency
self-sufficient
self-support
self-sustained
self-synchronize
T
self-talk
self-taught
W
self-will
self-willed
self-worth

Appendix C Validation of the Sample Size

We chose a mid-range (0.5) to determine our a priori sample size. From the graph below, with standardised difference of 0.5 and desired power 0.8, the sample size is approximately 120. After collecting our data, we were able to consider whether our choice of sample size was adequate.

The total 'before' competency had mean score $\bar{x}_b$ of 98 and standard deviation s_b of 14. Thus $\bar{x}_b / s_b = 7$ and we consider that differences ($diff_b$) of about 7 are of interest to us. Then $diff_b / s_b = 0.5$, is pleasantly in accord with our choice of the mid-range standardised difference of 0.5.

Similarly, the total 'after' competency scores had mean score $\bar{x}_a$ of 106 and standard deviation s_a of 15. Thus $\bar{x}_a / s_a = 7$ and with differences ($diff_a$) again of about 7, we have that $diff_a / s_a = 0.47$, again very similar to our a priori choice of 0.5.



From: Altman, D. G. Practical Statistics for Medical Research, Chapman and Hall, London 1991 (page 456), ISBN 0412276305

Appendix D Boxplots for WRL, Feedback and Degree Factors

Separate boxplots were generated for each of our three factors for both 'before' and 'after' total competency scores. Firstly, Figure 7B.1 shows the 4 clusters differentiating between students who took the WRL module and those who did not. Cluster 1 is the singleton with a very low score (40) before and after. Cluster 2 total scores are the highest in the sample with a median 'after' score of 127. Cluster 3 has generally lower 'before' scores which improve to mid scores 'after'. There is a marked rise in median scores and a slightly more improved after score for WRL in this cluster. There are several more outliers in the 'after' boxplot. Cluster 4 has mid scores 'before', with higher mid scores 'after', more so for WRL.

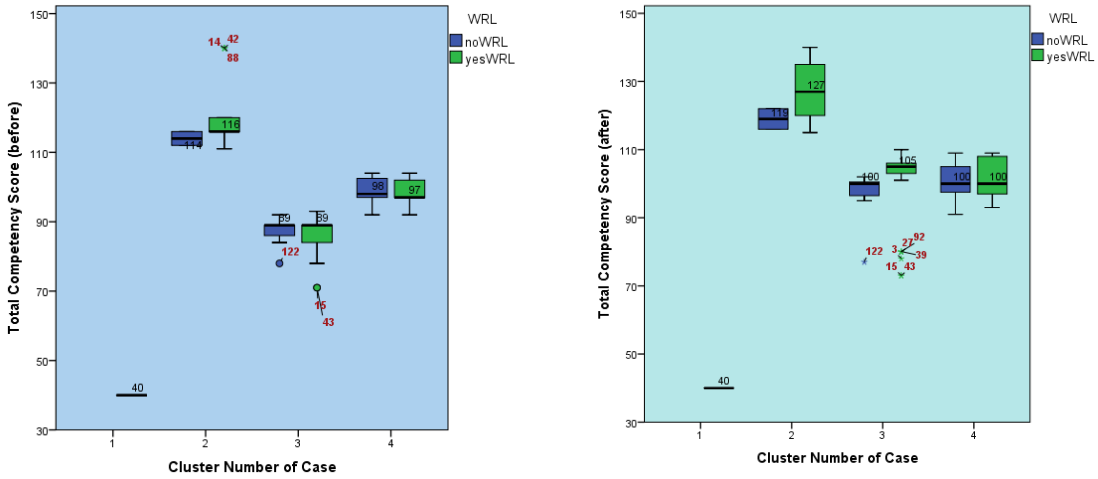


Figure 7B.1 Boxplots of 'before' and 'after' total competency for 4 clusters by WRL

For the feedback factor, Figure 7B.2 again shows the singleton in cluster 1 with a very low before and after score. Cluster 2 has a high score, both 'before' and 'after', whether there was feedback or not. In cluster 3 there is more differentiation overall of those that has feedback and those that did not. The interquartile ranges, hence the variability, for both clusters 2 and 3 is increased after the feedback. Lastly, cluster 4 has mid 'before' scores with higher-mid 'after' scores, and more so for feedback recipients.

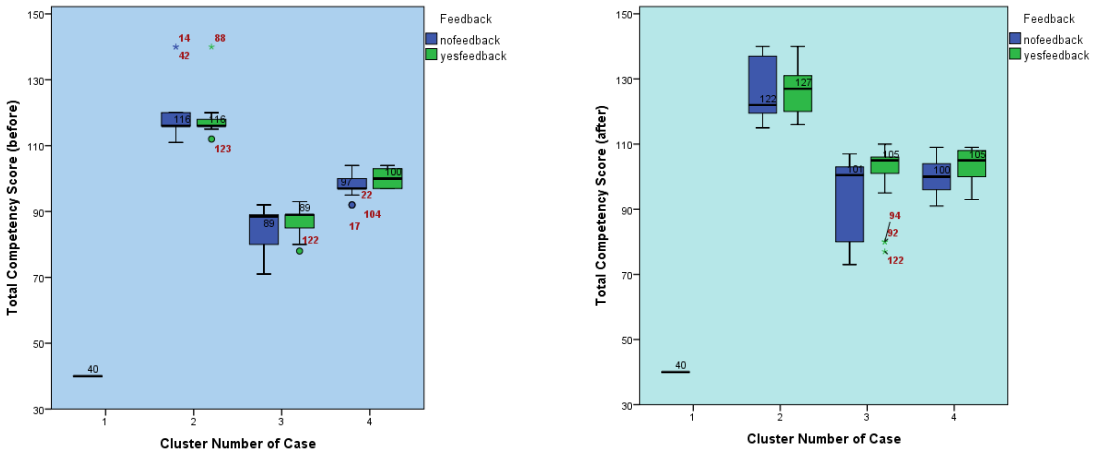


Figure 7B.2 Boxplots of 'before' and 'after' total competency for 4 clusters by Feedback

Figure 7B.3 shows that some FDSc students exhibit higher perceived initial competencies than their BSc counterparts. Cluster 1 has the BSc student with score of 40, cluster 2 has 8 FDSc students with an average of 123 and 19 BSc students with an average of 117. Cluster 3 has 40 BSc students averaging 87 and 8 FDSc averaging 83. Finally cluster 4 has 42 BSc students with an average score of 99 and 7 FDSc students averaging 97. Overall, BSc students had an average 'before' competency score of 97 and FDSc students had a higher average score of 101.
In the interests of completeness, we also generated a boxplot of total 'before' competency scores for 4 Clusters by degree type as well as by gender. Whilst the 4 cluster groupings are still apparent, there is virtually no difference in the average scored by the 20 females (97.4) and the average score of the 105 males (98).

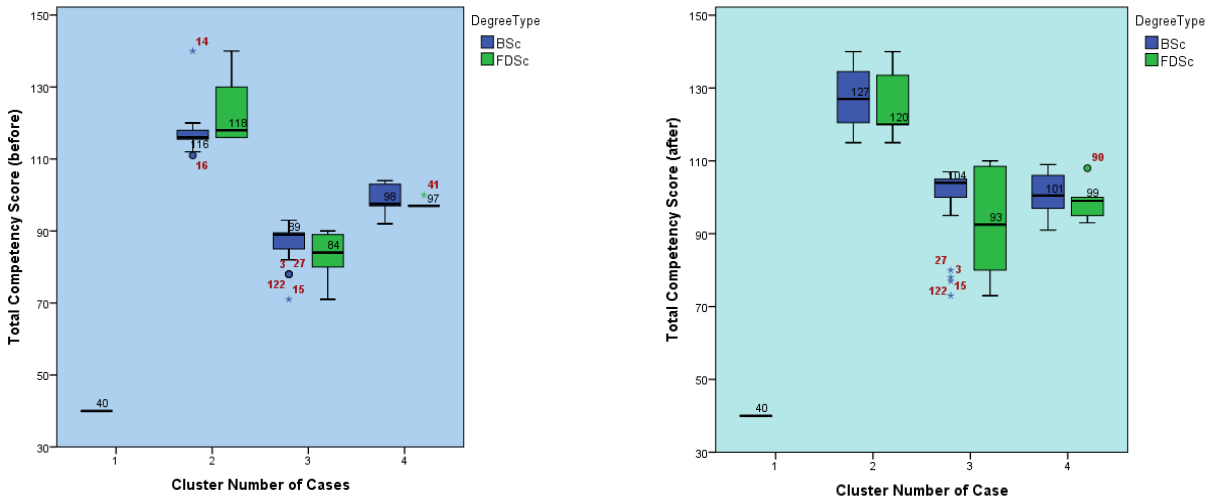


Figure 7B.3 Boxplots of 'before' and 'after' total competency for 4 clusters by Degree type

Appendix E Analysis of variance and table of parameter estimates for FinalWRLMark

Between-Subjects Factors

		Value Label	N
Feedback	0	nofeedback	34
	1	yesfeedback	34
Gender	F		11
	M		57
DegreeType	BSc		58
	FDSc		10
nage	1.00		45
	2.00		15
	3.00		8

Tests of Between-Subjects Effects

Dependent Variable: RModuleMark

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1161.191[a]	1	1161.191	9.059	.004
Intercept	271279.779	1	271279.779	2116.360	.000
Feedback	1161.191	1	1161.191	9.059	.004
Error	8460.029	66	128.182		
Total	280901.000	68			
Corrected Total	9621.221	67			

a. R Squared = .121 (Adjusted R Squared = .107)

Parameter Estimates

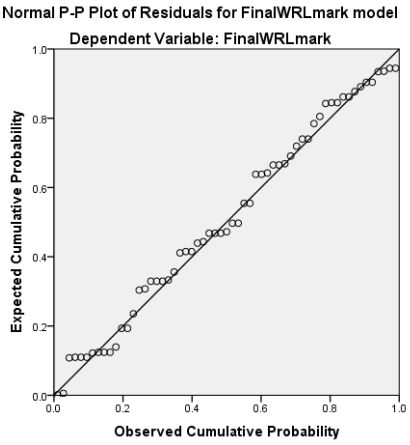
Dependent Variable: RModuleMark

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	67.294	1.942	34.658	.000	63.417	71.171
[Feedback=0]	-8.265	2.746	-3.010	.004	-13.747	-2.782
[Feedback=1]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Note: if we use feedback=1 as our parameterisation, the intercept becomes 67.29 – 8.27 = 59.02 and the feedback effect is +8.27

Appendix F P-P plot for FinalWRLmark model and alternative transformations



The P-P plot for the untransformed FinalWRLmark gives some evidence of possible heterogeneity.

The two transformed models (below) give very similar feedback effects.

<u>Using sqrt transformation:</u>

$\sqrt{FinalWRLmark}$ = μ + F + error

= 8.18 (if feedback=1)

= 8.18 – 0.55 (if feedback=0)
= 7.63 (if feedback=0)

i.e. *FinalWRLmark* = $(8.18)^2$ if feedback=1
= $(7.63)^2$ if feedback=0

FinalWRLmark = 66.9 (if feedback=1)
= 58.2 (if feedback=0)

Difference is 8.7 marks.

Using $\sqrt{FinalWRLmark}$ we would not accept homogeneity of variance using Levene's test (p=0.001).

<u>Using log transformation:</u>

$\log_e(FinalWRLmark)$ = μ + F + error

= 4.20 (if feedback=1)

= 4.20 – 0.15 (if feedback=0)
= 4.05 (if feedback=0)

i.e. *FinalWRLmark* = exp(4.20) (if feedback=1)
= exp(4.05) (if feedback=0)

FinalWRLmark = 66.7 (if feedback=1)
= 57.4 (if feedback=0)

Difference is 9.3 marks.

Using $\log_e(FinalWRLmark)$ we do not accept homogeneity of variance using Levene's test (p=0.01).

The corresponding P-P plots for these two new response variables were no improvement on the P-P plot above.

In conclusion, the sqrt and log transformations do not provide more acceptable models than our basic linear model with the module marks as the response variable.

Appendix G Full Competency Matrix of before competencies as generated by SPSS

	Btr	Bci	Bdm	Bpo	Bbc	Btt	Bps	Bcf	Bdi	Baf	Bmm	Bp	Bie	Bir	Brw	Bls	Bm	Bca	Bit	Bss
Btr	1	.829**	.847**	.674**	.727**	.501**	.811**	.827**	.768**	.739**	.669**	.716**	.759**	.723**	.562**	.525**	.569**	.642**	.444**	.417**
		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bci	.829**	1	.742**	.645**	.733**	.640**	.851**	.812**	.727**	.836**	.637**	.733**	.768**	.717**	.373**	.364**	.649**	.449**	.297**	.218*
	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.015
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bdm	.847**	.742**	1	.803**	.839**	.596**	.897**	.826**	.748**	.708**	.824**	.699**	.549**	.629**	.431**	.392**	.485**	.486**	.203*	.477**
	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.024	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bpo	.674**	.645**	.803**	1	.821**	.849**	.828**	.772**	.792**	.702**	.750**	.462**	.379**	.677**	.316**	.279**	.603**	.245**	.260**	.334**
	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.006	.003	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bbc	.727**	.733**	.839**	.821**	1	.729**	.827**	.929**	.702**	.789**	.787**	.675**	.571**	.654**	.185*	.135	.580**	.291**	.134	.241**
	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.039	.133	.000	.001	.136	.007
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Btt	.501**	.640**	.596**	.849**	.729**	1	.747**	.677**	.691**	.723**	.552**	.339**	.361**	.663**	.221*	.233**	.665**	.078	.347**	.181*
	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.013	.009	.000	.388	.000	.044
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125

Bps	.811**	.851**	.897**	.828**	.827**	.747**	1	.819**	.794**	.780**	.752**	.725**	.629**	.677**	.391**	.397**	.597**	.431**	.242**	.364**
	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.007	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bcf	.827**	.812**	.826**	.772**	.929**	.677**	.819**	1	.795**	.849**	.672**	.729**	.759**	.763**	.292**	.245**	.679**	.431**	.297**	.160
	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.001	.006	.000	.000	.001	.075
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bdi	.768**	.727**	.748**	.792**	.702**	.691**	.794**	.795**	1	.839**	.602**	.567**	.608**	.855**	.589**	.551**	.854**	.584**	.509**	.315**
	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Baf	.739**	.836**	.708**	.702**	.789**	.723**	.780**	.849**	.839**	1	.652**	.701**	.761**	.858**	.327**	.300**	.840**	.358**	.390**	.135
	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.001	.000	.000	.000	.134
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bmm	.669**	.637**	.824**	.750**	.787**	.552**	.752**	.672**	.602**	.652**	1	.669**	.348**	.513**	.320**	.276**	.399**	.357**	.035	.578**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.002	.000	.000	.694	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bp	.716**	.733**	.699**	.462**	.675**	.339**	.725**	.729**	.567**	.701**	.669**	1	.755**	.593**	.332**	.328**	.430**	.572**	.177*	.277**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.048	.002
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bie	.759**	.768**	.549**	.379**	.571**	.361**	.629**	.759**	.608**	.761**	.348**	.755**	1	.730**	.359**	.354**	.614**	.482**	.480**	.003
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.975
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bir	.723**	.717**	.629**	.677**	.654**	.663**	.677**	.763**	.855**	.858**	.513**	.593**	.730**	1	.600**	.552**	.840**	.511**	.648**	.237**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.008
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125

Brw	.562**	.373**	.431**	.316**	.185*	.221*	.391**	.292**	.589**	.327**	.320**	.332**	.359**	.600**	1	.982**	.457**	.868**	.784**	.744**
	.000	.000	.000	.000	.039	.013	.000	.001	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bls	.525**	.364**	.392**	.279**	.135	.233**	.397**	.245**	.551**	.300**	.276**	.328**	.354**	.552**	.982**	1	.418**	.846**	.794**	.730**
	.000	.000	.000	.002	.133	.009	.000	.006	.000	.001	.002	.000	.000	.000	.000		.000	.000	.000	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bm	.569**	.649**	.485**	.603**	.580**	.665**	.597**	.679**	.854**	.840**	.399**	.430**	.614**	.840**	.457**	.418**	1	.411**	.545**	.091
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.311
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bca	.642**	.449**	.486**	.245**	.291**	.078	.431**	.431**	.584**	.358**	.357**	.572**	.482**	.511**	.868**	.846**	.411**	1	.594**	.643**
	.000	.000	.000	.006	.001	.388	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bit	.444**	.297**	.203*	.260**	.134	.347**	.242**	.297**	.509**	.390**	.035	.177*	.480**	.648**	.784**	.794**	.545**	.594**	1	.361**
	.000	.001	.024	.003	.136	.000	.007	.001	.000	.000	.694	.048	.000	.000	.000	.000	.000	.000		.000
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
Bss	.417**	.218*	.477**	.334**	.241**	.181*	.364**	.160	.315**	.135	.578**	.277**	.003	.237**	.744**	.730**	.091	.643**	.361**	1
	.000	.015	.000	.000	.007	.044	.000	.075	.000	.134	.000	.002	.975	.008	.000	.000	.311	.000	.000	
	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125

Appendix H Confidence intervals of Sample correlations

Sample correlations r can be treated as approximately normally distributed provided the sample size n is quite large. n greater than 100 is sufficient.

The approximate variance of r is 1/4n. Using this variance an approximate 99% Confidence Interval can be calculated.

With 190 correlations and 121 (excluding the 4 anomalous ones) students using a Bonferroni correction, a 99% Confidence Interval is approximately (r – 0.18, r + 0.18)

For r=0.8, the 99% Confidence Interval is therefore approximately (0.62, 0.98)