Measuring qualification effects of a new pedagogy which embeds learning and assessment activities within each students rich professional context of practice

Technical Report

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1 Introduction

We report on the outcomes of our eSTEeM project, focused on a pedagogical approach implemented in three post-graduate modules for a recently introduced Computing qualification (F66 MSc in Computing), where the students' own professional context of practice, rather than fictitious case studies, is used to assess their understanding of and ability to apply what is taught in those modules, as well as to develop a wide range of research and employability skills as they progress through the qualification.

The project, which run over 12 months, conducted a preliminary evaluation of the approach and contributed to the definition of a generic framework to be used to evaluate its effectiveness within the qualification, with particular attention to cumulative effects along different pathways students may take, and culminating in a capstone research project module, where skills acquired through this type of pedagogical approach are particularly relevant.

The report compares and contrasts how the pedagogy was implemented in the modules under study (Section 2), gives a detailed account of the data analysis performed (Sections 3 and 4) introduces the framework (Sections 5) and offers a discussion of outcomes with conclusions on future work (Sections 6).

2 The pedagogy and its implementation

The project was concerned with the following postgraduate modules contributing to a number of qualifications across the STEM Curriculum:

- M811 Information security, which explores the professional and technical skills necessary to understand, document, manage and implement strategic and operational aspects of an organisation's information security.
- M813 Software development, which explores the principles and techniques of software development across the software life-cycle.
- M816 Data management, which explores the principles, practices and technologies required for data management across the data life-cycle.
- T802 Research project, which allows students to identify and tackle a research problem of their choice and relevant to their MSc.

M811, M813 and M816 are all 30 credit modules, with similar study length and structure expressed in study weeks (between 23 and 25 depending on the module). They contribute to a common set of qualifications (see Figures 1), although their role in each may be different (core vs. optional).
In particular, within the MSc in Computing, M811 is the first core module students encounter on the Information Security and Digital Forensics pathway, while M813 is the first core module on the Software Engineering pathway. M816 is optional across both pathways. T802 is the optional 60 credit capstone research project module for all those qualifications (a 30 credit capstone professional project is also available, which is not considered in this study).

2.1 M811, M813 and M816 common pedagogy

Developing professionally-relevant modules for our postgraduate students is a challenge: relevance to the unique context of practice of each of our students need to be maintained, while combining theory and practice so that all learners develop a deep understanding of the discipline, and a wide range of critical skills (Mueller, 2009), from the ability to interact effectively with others (e.g., communication, collaboration, leadership), to sense making and problem solving in the real world (e.g., reasoning, analysis, synthesis, evaluation, innovation), and to skills to allow personal growth (e.g., reflection, critical thinking, independent learning, self-direction). A deep understanding of discipline specific knowledge coupled with a broad set of skills for collaboration and knowledge application across disciplines (so-called T-shaped

Module	Credits	Level	Delivery	1st Pres
M811 Information security	30	PG	online	13K
M813 Software development	30	PG	online	14E
M816 Data management	30	PG	online	14K
T802 Research project	60	PG	online	12J (new edition)

Qual	M811	M813	M816	T802
MSc in Computing (F66)	optional	optional	optional	optional
MSc in Computing (F66) (Information Security and Digital Forensics)	core	optional	optional	optional
MSc in Computing (F66) (Software Engineering)	optional	core	optional	optional
MSc in Technology Management (F36)	optional	optional	optional	optional
MSc in Systems Thinking in Practice (F47)	optional	optional	optional	optional
MSc in Engineering (F46)	optional	optional	optional	core
MSc in Advanced Networking (F56)	n/a	n/a	n/a	optional

Figure 1: Modules and qualifications

abilities (Guest, 1991) is what our graduates must exhibit to be employable in today's rapidly changing and complex economy.

To meet this challenge, M811, M813 and M816 have adopted a common pedagogy, which embeds learning and assessment activities within each student's rich and unique context. Looking at the literature for the past decade, when developing professionally-relevant modules, value has been found in pedagogical approaches which present learners with real-world open-ended situations, rather than toy examples and fictitious problems: learning through tackling real-world open-ended problems narrows the gap between what students do as part of their study and what they encounter in their profession and, as such, is a welcome advancement in the way practical disciplines are taught. Therefore, the core of the approach is to blend the learner's study and their rich real-world context of practice in a form of situated learning (Lave and Wenger, 1991), backed up by authentic assessment (Darling-Hammond and Snyder, 2000). A key challenge for this approach is how to bring each student's context of practice to bear into their learning, and vice versa allow students to reflect their learning into that context. This brings two further challenges: firstly, to match the module content to the type of problems our students may be facing in their practice; secondly, to ensure equitability of assessment, both in terms of the independent work required of each student, the measures applied to its assessment, and the level of effort expected of tutors and examiners to assess it. In each module design, judicious choices were therefore required to:

- identify, within the body of knowledge of each discipline, content of broad applicability, hence suitable for a wide range of professional problems and contexts;
- enable situated learning, by allowing students to choose within each module their own specific professional problems, directly exercising therein knowledge and skills acquired while studying, and then reflecting on their learning;
- design authentic assessment tasks and rubrics to allow: students to exercise knowledge and demonstrate their skills on meaningful tasks in their own context of practice, and to reflect on that practice; and tutors to assess each student's individual work based on a set of explicit assessment criteria;
- provide learners with the research skills and opportunities to conduct and share their own independent enquiries into topics relevant to the module and their profession and/or at the leading edge of the subject, but not necessarily addressed within the module.

Table 1 summarises how each of the modules has addressed such challenges. Specifically:

Table 1: Customisation of pedagogy

	M811	M813	M816
Content	Based on the current international family of standards for Information Security, ISO 27000	Based on the Software Engineering Body of Knowledge (SEBOK), with choice of specific practices and techniques which are widely adopted in practice in the life-cycle of information systems	Follows the Data Management Association (DAMA) Data Management Body of Knowledge (DMBOK) Framework
Situated learning	Student's choice of organisational context and problem to be addressed via the development of an information security management system; application of module knowledge and skills within that organisational context to address the problem, including interaction with key stakeholders	Student's choice of organisational context and problem to be addressed via the development of an information system; application of module knowledge and skills within that organisational context to address the problem, including interaction with key stakeholders	Student's choice of organisational context and problem to be addressed via the development of data management policies, procedures and systems; application of module knowledge and skills within that organisational context to address the problem, including interaction with key stakeholders
Authentic assessment and reflection on practice	TMA01 to 03 (supported by running example)	Formative assessment, and TMA01 to 03 (supported by running example)	Formative assessment and TMA01 to 03
Independent learning	Leading edge activities and discussion forum	Leading edge activities and discussion forum	n/a
Research skills	Research strand and EMA	TMA01 to 03 and EMA	TMA01 to 03 and EMA

- Each module addresses a specific subject area, with its content based on existing standard and/or bodies of knowledge, appropriately tailored to the need of our students.

- In all modules, students choose their own context and problem of application, which is the basis of much of their continuous assessment. An early formative step, where explicit feedback and approval from tutor is obtained, is included to mitigate the risk of an inappropriate choice.

- In all modules, tasks which link the content of the module to the context of application are the basis of the continuous assessment, which includes both application of knowledge and skills to context, and reflection on that practice. In two of the modules, M811 and M813, to help students understand what is expected of them in the application of knowledge and skills in their own context, a running example is provided in the study materials. Alongside producing a range of artefacts which demonstrate mastering of specific knowledge, approaches and techniques, students are asked to provide a rationale for their choices in the process of application within their context, and to discuss any lessons learnt. They are then required to reflect critically on their experience and to build a commentary on the extent the applied theories, principles and techniques have been fruitful, appropriate, deficient, over complex, or just plain wrong. Reflective practice is widely acknowledged as an effective process for continuous learning (Schon and DeSanctis, 1986), which is of particular relevance to the working professional. On all modules, it is a key aspect of assessment and validation of learning. Alongside the tasks set for the students, for each piece of assessment, a rubric provides explicit criteria for evaluation, which are used by the tutors to assess each student's original work. The rubric allows tutors to marry qualitative criteria with quantitative measures, so that they can assign grades on a spectrum from distinction to fail. Its design is particularly critical as the rubric is what allows us to ensure consistent marking across students' cohorts, and to control the time tutors spend marking assignments.

- Two of the modules, M811 and M813 require students to engage in 'Tracking the leading edge' independent learning activities, and to use module fora to share insights with their peers: M813 uses a dedicated forum for this activity, while M811 the generic module forum. The activities require students to track the leading edge of their module discipline by engaging with a variety of online resources, beyond what the module provides, typically by expanding and complementing topics covered by the module, chosen by the student because particularly relevant to their own practice, or simply for personal interest. Appropriate skills development is included in each module, and

a sample of the students work is assessed via the continuous assessment (more in Section 2.4).

2.2 T802 pedagogy

This capstone project module allows students to identify and tackle a research problem of their choice, which is relevant to their own MSc. It is worth noticing that many students choose research problem relevant to their professional practice, while some students choose purely academic topics, often those suggested by academic staff. Each student is assigned a supervisor, who provides the main support and pastoral care throughout the project. Pedagogical materials are provided around key research topics and skills, including: literature review and referencing; research methodology and techniques; data presentation, analysis and interpretation; writing skills and research ethics. The formative continuous assessment, currently in the form of 4 TMAs, takes the student through an incremental and iterative process, with each iteration building upon the previous one, adding new skills and new content to the report, which eventually becomes the dissertation submitted by the student for summative assessment at the end of the module. In relation to the other modules, T802 takes research skills development to the next level, by covering news skills around conducting primary research, which are not addressed by the other modules. On the other hand, the other modules develop a range of skills around identifying and scoping a suitable research investigation and conducting secondary research. Therefore, part of the motivation for including T802 in this study was to explore the extent the pedagogy in the other modules provides an effective scaffolding for T802 students.

2.3 M811, M813 and M816 Assessment

In the three modules, there are three points of summative continuous assessment (TMA01 to 03), with each continuous assessment script marked by the student's tutor. The current assessment structure for the three module is summarised in Table 2.

All three modules also include an end-of-module summative assessment (EMA), which is doubled marked, with wide discrepancies dealt by the Chair of the Module Review Panel[1] via 3rd marking. The EMA assesses primarily research skills and takes the form of an essay addressing a brief which is very similar in the three modules, in that it requires the student to write a critical review of a topic of their choice, based on three chosen articles, related to the content of the module under study and of relevance to practitioner community in general

[1]Previously, Award Board.

Table 2: TMAs

Module	TMA01	TMA02	TMA03
M811	Weight: 33.3% Marks: Technical knowledge and skills (70%) Reflection on practice (20%) Independent learning (10%)	Weight: 33.3% Marks: Technical knowledge and skills (45%) Reflection on practice (45%) Independent learning (10%)	Weight: 33.3% Marks: Technical knowledge and skills (50%) Reflection on practice (40%) Independent learning (10%)
M813	Weight: 30% Marks: Technical knowledge and skills (70%) Reflection on practice (10%) Research skills (20%)	Weight: 40% Marks: Technical knowledge and skills (70%) Reflection on practice (10%) Research skills (20%)	Weight: 30% Marks: Technical knowledge and skills (70%) Independent learning (10%) Research skills (20%)
M816	Weight: 20% Marks: Technical knowledge and skills (65%) Reflection on practice (10%) Research skills (25%)	Weight: 40% Marks: Technical knowledge and skills (65%) Reflection on practice (10%) Research skills (25%)	Weight: 40% Marks: Technical knowledge and skills (65%) Reflection on practice (10%) Research skills (25%)

and student's own practice. Small differences of what is explicitly asked of the student in the brief are indicated in Table 3.

Table 3: EMA brief

Requirement	M811	M813	M816
Type of article	3 research or 2 research and 1 professional	3 peer-reviewed	3 peer-reviewed
Explanation or relevance	yes	yes	yes
Justification of choice of article	no	yes	no
Description of topic	yes	yes	yes
Summary of each articles	yes	yes	yes
Comparison and evaluation of articles	yes	yes	yes
Potential impact of articles on theory or practice, with suggestions on how it may be incorporated	yes	yes	yes

Generic qualitative marking criteria are provided to markers to help them assess the quality of the EMA with respect to standards related to the possible classification (from Distinction all the way to Fail), based on common practice at the OU. The one used by M811 is given as an example in Figure 2: the other modules use similar criteria.

In addition, both M811 and M813 provide a number of specific 'indicators' for tutors to help them mark the EMAs (see Figure 3 for M811), based on the EMA guidance given to students, and a marking table which maps indicators to numerical values (see Figure 4 for M811).

For the situated learning, the student's choice of organisational context and problem is a critical success factor. In M813 and M816, formative assessment is used early in the study calendar (around week 2) for students to flesh out their choice and discuss with their tutor. This formative activity is carried out at the start of the module, via a special VLE forum, which allows private conversations between students and tutors, but can also be accessed for monitoring by the module team. In the original M811 design, students were advised to contact their tutor directly should they need further guidance beyond what is provided in the study materials. A forum similar to those of the other modules was introduced in the 3rd presentation. The forum has the added bonus of being visible to the module teams for monitoring academic standards and retention.

Marking Criteria □ Grades □	**Distinction**	**Merit**	**Pass**	**Fail & Resit**	**Fail**
Question coverage	Good depth & breadth of question coverage;	Good question coverage but imbalance in respect of breadth vs. depth;	Good question coverage but mainly in respect of breadth;	Limited coverage with emphasis on description of reading;	Very limited coverage; mainly a descriptive account of reading
Knowledge and understanding of underlying concepts and principles of information security management, and especially of the importance of process, lifecycle and quality	Authoritative interpretation of concepts & principles; relates research to process &/or InfoSec management lifecycle &/or quality where appropriate; wider reading.	Sound in respect of concepts & principles; relates research to process &/or InfoSec management lifecycle &/or quality where appropriate; wider reading.	Legitimate interpretation of most important concepts & principles; relates research to at least one of process, lifecycle & quality;	'Literal' or 'rote-learnt', occasionally incorrect, understanding of important concepts & principles; largely descriptive account of research which is occasionally related to course;	Essential concepts not understood clearly; largely descriptive account of research which is related to course in a forced or contrived way;
Ability to evaluate concepts, frameworks and/or techniques proposed in recent professional, scholarly and research literature	Comprehends and evaluates new and complex concepts and frameworks from demanding sources of research & scholarship against clear and relevant criteria;	Comprehends and evaluates new concepts and frameworks from a variety of sources of research & scholarship against stated criteria;	Comprehends and describes relevant new concepts and frameworks from a variety of sources of research & scholarship	Descriptive rather than evaluative account of new concepts and frameworks from relatively undemanding sources of research & scholarship	Descriptive account concepts from 'magazine' style articles relating to information security management
Ability to deploy a full range of analytic skills in relation to course materials, professional, research and scholarly sources, and personal experience of course related activities	Full range of skills evident; inc. synthesis; shows clear insight	Comprehensive range of skills; excludes/weak on synthesis; some evidence of insight	Varied analytic skills	Mainly descriptive but some evidence of other skills	Entirely descriptive
Capacity to form judgements that are demonstrably informed by relevant professional, legal, social and ethical considerations	Sound, informed opinion; evidence-based judgement relating to legal, social, ethical dimensions.	Valid, evidence-based opinion relating to some legal &/or social &/or ethical aspects.	Derives the most important conclusion from evidence.	Opinion based on appeals to 'general knowledge' or 'common sense'	Uninformed opinion, speculation
Ability to communicate clearly and effectively to examiners who constitute a *knowledgeable* and *specialist* audience.	Clear, concise, structured communication using illustration where appropriate. Aimed at a knowledgeable and specialist audience	Clear, concise, structured communication, using illustration as appropriate. Broadly successful in writing for audience.	Accessible communication style, perhaps lacking in structure.	Ineffective communication, indiscriminate inclusion (exclusion) of material.	Style obscures what is being conveyed, difficult to comprehend, requires second or third reading.

Figure 2: M811 EMA criteria

Code	Indicators
M1	based on three recent peered-reviewed articles. For a distinction, at least two scholarly articles are required.
M2	describes the topic common to them...
M3	provides full bibliographical reference of, and direct web link to, chosen articles
M4	references and cites all articles, module texts and additional reading
M5	indicates accurate word count, which is under the limit.
K1	discusses why the topic is of relevance to the information security management community and possibly to own organization, and how it relates to the module
K2	justifies the choice of articles
K3	summarizes each article
AS1	compares and contrasts their respective contributions to the topic
AS2	evaluates their contributions to the topic
AS3	discusses the extent to which the ideas in the articles might or might not be used to change theory and/or practice and makes suggestions as to how any change might be incorporated
AS4	discusses relation to relevant course materials, TMA activities, and any additional reading undertaken (beyond articles researched)

Figure 3: M811 EMA marking indicators

2.4 M811, M813 and M816 research skills development

Research skills are developed by all the modules and assessed as indicated in Section 2.3. There are differences in the way the modules approach research skills development: in M811, there is an explicitly taught research strand throughout the module which includes formative self-assessment, while summative assessment only takes place in the EMA; on M813 and M816, there is no explicit research strand, but skills are build up incrementally around specific tasks within the three TMAs, which complement the summative assessment provided by the EMA. The preparatory activities for TMAs and EMA on M813 make use of some of the materials developed for the M811 research strand.

Student name		Student PI		
Code(s)				**Yes/No?**
M1 to M3	**M1 to M3 are essential. If the articles are not peer-reviewed or cannot be clearly identified, then assign only 20 marks in total, allowing the student to re-sit the EMA. Otherwise, if the references are incomplete or the links are missing (but the articles are nevertheless identifiable), then deduct up to 10. Deduct 0.5% for each instance of exceeding the word count by up to 1%.**			
M4, M5	**deduct up to 5 marks in total if not included**			
Code(s)	**Total available**	**Your score (0 to 5)**	**Your mark**	**Further guidance**
K1	5			relevance to own organisation is not essential, but relevance to Information Security Management community and M811 are
K2	5			full marks should be given only for choices of articles whose contributions balance each other
K3	20			good summaries should be brief and provide a clear indication of the aim of the work, the main contributions and how they were reached
AS1	20			
AS2	20			
AS3	20			
AS4	10			
totals	100			
		deductions		including for exceeding word count
		final mark		
Overall comment				

Figure 4: M811 EMA marking table

Table 4: Research activity structure for M811, M813 and M816

Module research structure with assessment and other mileposts			
	M811	M813	M816
Week 1	IL taught: Introduction to tracking the leading edge	READ taught: Finding and reading academic articles	READ taught: Finding and reading academic articles
Week 2	IL activity (every week)	IL taught: Introduction to tracking the leading edge	
Week 3		IL activity: Tracking the leading edge	
Week 4	READ taught: Introduction to information security research		READ activity: The impact of Big Data on data management
Week 5		READ activity: Comparing model-driven and Agile software development	TMA01 (READ, guided SUMM assessed)
Week 6		TMA01 (READ, guided SUMM assessed)	
Week 7	TMA01 (IL assessed)		
Week 8			Christmas Break
Week 9		READ activity: Test-driven development	
Week 10	SUMM taught: Summarising, comparing and contrasting		
Week 11			
Week 12			READ activity: The impact of mobile computing on data management
Week 13			TMA02 (READ, guided SUMM assessed)
			Continued on next page...

Module research structure with assessment and other mileposts			
	M811	M813	M816
Week 14		TMA02 (READ, guided SUMM assessed)	
Week 15	TMA02	READ activity: Enterprise systems integration	
Week 16			EMA Preparation
Week 17			READ activity: The impact of cloud computing on data management
Week 18	CRIT: Writing a critical review		
Week 19			TMA03 (READ, guided SUMM assessed)
Week 20		TMA03 (READ, guided SUMM, IL assessed)	
Week 21	TMA03	SUMM, CRIT taught: EMA Preparation	
Week 22	EMA (READ, SUMM, CRIT assessed)		EMA (READ, SUMM, CRIT assessed)
Week 23			
Week 24		EMA (READ, SUMM, CRIT assessed)	
Week 25			
Week 26			
Notes	Tracking leading edge throughout	Tracking leading edge throughout	

The research skills development structure of the three modules is given in Table 4. Briefly, M811 and M813 include 'Independent Learning' (IL) tasks, by which a 'goody bag' of resources is accessed by students every week so that they can explore the leading edge, but without requiring module team input. Each module has 'Finding and reading academic articles' (READ) activities, although M811 calls this 'Introduction to information security research' (more on this below). Then the paths diverge:

- M811 presents 'summarising, comparing and contrasting skills' (SUMM) and then

'writing a critical review' (CRIT) skills, whereas M813 and M816 build on the target topic relevant skills building on READ.

- M813 uses EMA Preparation to add some SUMM and CRIT skills in time for the EMA. Instead, M816's EMA Preparation requires students to discuss their chosen EMA topic and articles with tutor. In fact, as of 16K, M816 students have to seek approval of their EMA topic and the three articles from their tutor to guard against a poor choice of topic and/or articles.

- M811 interleaves research skills development based on formative self-assessment, with technical work assessed in TMAs but, other than IL assessment in TMA01, does not assess the students' performance in research skills until the EMA. Both M813 and M816 use the TMAs to develop and assess READ skills, then assess all research skills in the EMA.

A more detailed structure of the research activities is given in Appendix A.

2.5 In-presentation adjustments

Post-production, all modules have made small adjustments to the way the pedagogy is delivered to students as part of their annual review cycle related to the evaluation of presentation outcomes, but also based on the work of this project, which has provided an opportunity for a detailed analysis and comparison of the modules. The adjustments are summarised in Table 5.

3 Data sets

A wide range of data is available related to each of the modules, including standard key performance indicators (KPIs) around students retention, attainment and satisfaction, as well as marked assessment scripts, both continuous and end of module, and forum postings. However, to meet the objectives of the project, we also needed ways to:

- aggregate data along qualification pathways chosen by students, to identify and analyse possible qualification effects; and

- perform in-depth qualitative analysis of large data sets of unstructured text, to analyse how the pedagogy helps students develop specific research skills, both within individual modules and in their progression towards their Masters qualification.

Table 5: In-presentation adjustments

Module	Trigger	Change
M811	student comments that more assessment guidance was needed	version of tutor notes distributed to students
	work around choice of organisation and scope not visible for monitoring	introduction of online forum as in M813 and M816
	high drop-out at start	change TMA01 marking scheme to reward early engagement with choosing organisation and scope
M813	high volume of students questions to ALs around the choice of organisation and scope, making this initial formative assessment very time consuming	further guidance and advice to students provided as part of a preparatory activity
	TMA marking rubric deemed too detailed, hence unnecessarily time consuming	rubric simplified by aggregating some of the criteria and allowing higher levels of feedback
	late students engagement with initial formative assessment, with impact on TMA01	AL to contact students proactively at module start
	high rate of EMA third marking due to different markers interpretation of marking table and weight amplification effects	simplification of EMA marking scheme and elimination of weights
	high drop-out at start	change TMA01 marking scheme to reward early engagement with choosing organisation and scope
M816	high drop-out at start	change of weight of TMAs: lower weight for TMA01 and higher weight for TMA02 and TMA03
	marking table and weight amplification effects	simplification of EMA marking scheme and elimination of weights
	poor EMA performance	students have to seek approval of their EMA topic and the 3 articles from their tutor

We have addressed the former by identifying a number of case studies concerning students on specific pathways, which includes a combination of two or more of the modules under study, and the latter by developing semi-automated text selection and extraction techniques, which we have initially applied to forum postings as proof-of-concept.
The following sections summarise our analysis and main findings, looking separately at quantitative and qualitative data.

4 Quantitative data analysis

4.1 Overall modules performance

To paint a picture of the overall performance of the modules under study, we collected data related to standard KPIs for all module presentations which have been completed to date, and compared them with three other modules: two of them belongs to the same specialist pathways as M811 and M813, and adopt a more traditional pedagogy and assessment, including an exam instead of an EMA; the other is an optional module, which adopts a similar pedagogy of situated learning, and a final EMA for assessment. The comparators are all modules within the MSc in Computing:

- M812 Digital Forensic, the second core module on the Information Security and Digital Forensics pathway, intended for study after M811;
- M814 Software Engineering, the second core module on the Software Engineering pathway, intended for study after M813;
- M815 Project Management, an optional module on all pathways, like M816.

4.1.1 Retention data

The first data set relates to student retention. Table 6 summarises the number of students registered at the start of each module presentation to date (including comparator modules), while Table 7 summarises student withdrawals between module registration and TMA01 submission date for the modules under study. M811, M813 and M816 range from 2-11% (mean 5%), which is higher than for M812, M814 and M815 which range from 0-3% (mean 2%). However, M813 figures are closer to the comparators.
Table 8 summarises student pass rate for M811, M813 and M816, and their comparators, where pass rate is the number of students on a module presentation who successfully complete all the assessment (TMAs and EMA) against the total number of students registered at

Table 6: Number of registered students at start

	M811	M813	M816	M812	M814	M815
13K	96					
14E		98		79		119
14K	96		98		55	
15E		107		92		209
15K	129		94		59	
16E		100		102		184
16K	130		96		60	

Table 7: Withdrawals up to TMA01

	M811	M813	M816	mean	M812	M814	M815	mean
13K	11%							
14E		3%			3%		2%	
14K	2%		4%			0%		
15E		2%			1%		3%	
15K	6%		10%			2%		
16E		5%			3%		0%	
mean	6%	3%	7%	5%	2%	1%	2%	2%

Table 8: Pass rate

	M811	M813	M816	mean	M812	M814	M815	mean
13K	54%							
14E		62%			62%		80%	
14K	65%		70%			89%		
15E		62%			70%		82%	
15K	58%		66%			77%		
16E		65%			70%		77%	
mean	59%	63%	68%	63%	67%	83%	80%	77%

module start. The student pass rate for the former ranges from 54-70% (mean 63%), which is lower than for the latter which ranges from 62-89% (mean 77%).
So, at face value, in terms of retention the modules under study under-perform in relation to their comparators. However, we can't necessarily infer that this is due entirely to their pedagogical approach, as other confounding factors need to be accounted for. First of all, student numbers are very small and only a handful of presentations have been completed, so differences between presentations may not be statistically significant. Also, both M811 and M813 are recommended[2] first core modules on their pathways: given the open nature of the qualification, it may well be that their students are less ready for postgraduate study, hence perform more poorly than students who have already successfully completed other postgraduate modules, as would normally be the case for students on the follow-up core modules M812 and M814. Finally, M815 is unique in that it is often studied as a one-off for CPD purposes by practicing project mangers who are seeking professional upgrade and/or certification, hence tend to have better retention overall in the programme. Therefore, more data and a more in-depth analysis of our students's study history will be required in future to identify meaningful associations and reach more definite conclusions.

4.1.2 Performance data

Figure 5 compares student performance for M811, M813 and M816 with their comparators, including performance in continuous assessment, EMA and overall grade. From the figure, there doesn't appear to be any significance difference in mean values of continuous assessment and EMA scores. However, the distribution of classification appears different with the modules under study having a lower percentage of Merit grades and a higher percentage of Pass grades. As an outlier, M816 has so far not registered any distinction rate. Also noticeable is the improvement in performance in the 2015K presentation of M811, which coincided with a version of the tutor notes be made available to students.
Given that the mean attainment is the same across both groups of modules, it appears there are significant differences in the way Module Review Panels (MRPs) set their classification borderlines. This is not unexpected due to the fact that MRPs currently work very much independently of each other. However, this is likely to change as a result of the newly introduced Cluster and Progression Boards, which will aim at standardise practice across modules within a qualification. As a first step, an investigation should follow into where classification boundaries are usually set in the modules under study.

[2]Although student are not obliged to follow this recommendation.

		OCAS	OES	Distinction	Merit	Pass	Fail
M811	2013K	56%	57%	3%	22%	65%	10%
	2014K	59%	54%	1%	33%	52%	14%
	2015K	65%	56%	12%	31%	48%	9%
M813	2014E	74%	63%	10%	27%	52%	11%
	2015E	73%	64%	16%	19%	58%	7%
	2016E	73%	63%	8%	26%	61%	6%
M816	2014K	67%	58%	0%	18%	78%	4%
	2015K	66%	59%	0%	16%	80%	4%
mean		**67%**	**59%**	**6%**	**24%**	**62%**	**8%**
M812	2014E	61%	60%	9%	43%	39%	9%
	2015E	60%	58%	4%	43%	43%	10%
	2016E	63%	59%	9%	38%	41%	11%
M814	2014K	70%	59%	6%	31%	63%	0%
	2015K	70%	60%	6%	33%	56%	0%
M815	2014E	69%	63%	6%	59%	29%	6%
	2015E	70%	62%	10%	47%	40%	3%
	2016E	69%	59%	5%	51%	41%	2%
mean		**67%**	**60%**	**7%**	**43%**	**44%**	**5%**

Figure 5: Student performance

4.1.3 Student satisfaction data

Students satisfaction data are given in Appendix A. It must be stressed that these are based on very small samples (low survey returns over low populations), so they are not necessarily statistically significant: in fact, we know that they tend to be skewed by either highly satisfied or highly dissatisfied respondents. Nevertheless, the emerging picture appears to indicate that the modules under study perform overall at least as well as their comparators. Within the group, M811 and M813 seem to perform slightly better than M816.

4.2 Aggregated data

In order to identify possible qualification effects, we needed to identify students that have already completed different combinations of the modules under study with the MSc qualification, culminating in the T802 capstone project, as well as analysing in detail their performance data as they have progressed through their qualification.
Alongside this cohort of students, we also wanted to find some comparator cohorts, and possibly identify tutors who may be able to provide a perspective on the pedagogy.
This is detailed in the next sections.

4.2.1 Student journeys

We considered all students, since the introduction of the new qualification, who have studied M811, M813 and M816 in any combination. The pie chart in Figure 6 gives an indication of the more frequent combinations.
Of those students, 16 have completed T802: the breakdown of their performance is given in Figure 7, where comparator modules studied are also included. The figure also indicates when each module was studied. Corresponding classification distributions are given in Figure 8.
These students' T802 classification distribution is given in Figure 8.

4.2.2 Comparing student cohorts

We aimed at comparing the performance of the above cohort against other groups of students. For this purpose we chose the two following groups:

- all T802 students on the MSc Computing, regardless of their choice of modules
- all T802 students from the MSc in Advance Networking which does not include any of the modules under study.

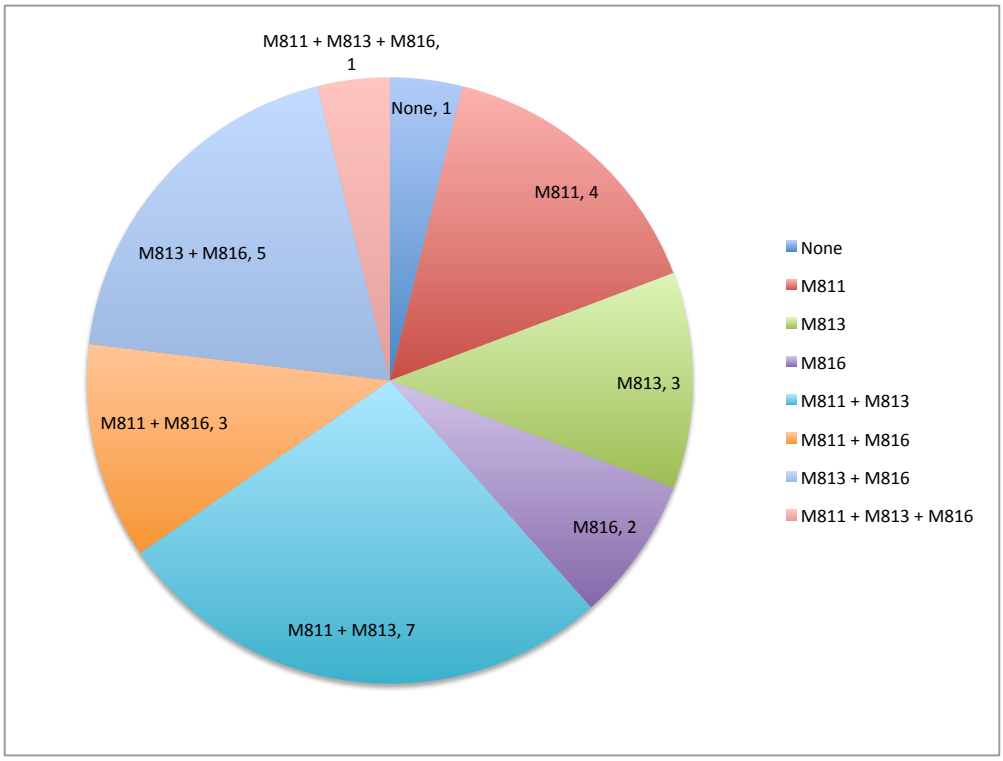

Figure 6: Combinations of modules studied

Anon	EMA		EMA		EMA		EMA									
	T802		M811		M813		M816		M812		M814		M815		Other	
SD01	D	15B	P	13K	P	14E			D	14E					D	T828 13K
SD02	P	15J	M	13K	P	14E					P	14K	M	15E		
SD03	D	15J			M	13E					D	14K			D	M865 12K
SD04	M	15J	P	14K					P	14E					P	T828 14K
SD05	P	15J			P	14E	M	14K								
SD06	P	15J	P	14K			P	14K							P	T848 13K
SD07	D	15J					M	14K					D	14E	M	T824 13E
SD08	R	16B	P	13K	P	15E					P	14K			p	T848 16L
SD09	M/D	16B	M	14K	D	15K			D	15E					D	T828 14K
SD10	P/R	16B	P	13K			P	14K	P	15L					P	T848 15E
SD11	M/D	16B	D	13K	D	15E	P	14K	D	14E						
SD12	M/D	16B			D	14E					P	14K	M	15E	M	T848 13K
SD13	P/D	16B	D	14K	D	14E			M	14E	P	14K				
SD14	P	16B	P	13K					15E	P					M	Tu811 14E
SD15	M	16B									P	14K	M	14E	P	T848 15E
1D16	P/R	16B	P	13K			P	14K	M	15E					M	T824 14E

Figure 7: Performance of students in the cohort under study

	T802		M811		M813		M816		M812		M814		M815		Other
R	1	0.0625	0												
P	4	0.25	7		4		4		2		5		0		5
M	2	0.125	2		1		2		2		0		3		4
D	3	0.1875	2		4		0		3		1		1		2
M/D	3	0.1875													
P/R	2	0.125													
P/D	1	0.0625													
Total	16	1	11		9		6		7		6		4		11

Figure 8: T802 distribution of classifications for the cohort under study

The performance of these two groups of students is given in Table 9 and 10. Note that, at this point in time, the first set is the same as the cohort under study as all students who have completed the qualification have also studied some combination of M811, M813 and M816.

Table 9: Outcomes for T802 students studying for MSc Computing (15B,15J & 16B)

Result	Number	%
RESIT	1	6.25
PASS	6	37.50
MERIT	4	25.00
DISTINCTION	5	31.25
TOTAL	16	100

Table 10: Outcomes for T802 students studying for MSc Advanced Networking (15B, 15J & 16B)

Result	Number	%
RESIT	7	26.92
PASS	13	50.00
MERIT	5	19.23
DISTINCTION	1	3.85
TOTAL	26	100

Although numbers are very small for statistical significance, it appears MSc Computing students (which are the same as the cohort under study, at this point) perform better than MSc Advanced Networking students overall, showing higher proportions of merit and distinction classifications.

4.2.3 Tutors practice

We have also identified T802 tutors who teach across some of the other modules under study. Although not yet done, we intend to interview them in future work to elicit their perspective with regard to the students development across the modules and as preparation for T802.

4.3 Module teams' and tutors' presentation workload

We were interested in quantifying the workload related to this type of pedagogical approach for both module teams and associate lecturers, and in comparison with the more traditional

Table 11: Modules tutored

ID	Std. Modules		Capstones	
AL1	M811	M816	T802	
AL2	M811		T802	T847
AL3	M813		T802	T847
AL4	M813		T802	

approach in the comparator modules. The latest data (2015-2016), based on institutional management information, is summarised in Table 12. The presentation staff figures refer to cost of central or regional academic staff on presentation module teams. Although only approximate of effort – the cost is based on salary points, so it is not a true reflection of effort, they seem to confirm that modules adopting the approach under study are cheaper to run: this can be explained by the fact that the assessment is written once and re-used on all presentations, which is also the case for the comparator M815. On the other hand, modules with traditional assessment, which needs substantial rewrite at each presentation, are understandable more expensive.

Some AL have reported that marking students' assignments is more demanding (but also more rewarding) due to the fact that there is no universal 'sample answer': students are required to situate their learning within their context of practice, hence each student's assignment is in some sense unique, and generic criteria are applied by markers to assess the work. Nevertheless, their payment band is the same as that of the comparator modules (except M812, which is higher due to an extra online activity for tutors). When all costs (fixed and variables) are considered, the overall module contribution is higher for the modules under study (and M815) in comparison to the more traditional M812 and M814.This is not surprising given that assignments are written once and reused over the modules lifetime, while for traditional modules assignments need to be substantially rewritten every year.

Table 12: Management information (2015-2016)

	M811	M813	M816	M812	M814	M815
Presentation staff (£)	19,954	11,540	15,114	25,632	25,985	13,151
Contribution	64%	70%	62%	57%	48%	79%
AL band	4	4	4	5	4	4

5 Qualitative data

As part of the project we have developed a proof-of-concept framework to support the analysis of large qualitative data sets. In its current form, it is tailored to module online fora, although it is designed to be a generic framework, so that it can be extended to other data sets (as discussed in the future work section of this report).
The framework includes a number of software tools designed to filter and consolidate data from module fora. For instance, filtering forum posts allows us to reduce significantly the number of posts to review (up to 19% in our tests of the system), making it a more manageable task. Further, the filtered posts are presented as consolidated reports, so removing the need to access individually every post in every forum for each module presentation that is part of the analysis. Therefore, the framework has the potential to deliver considerable time and effort savings: something to test in future work.
Among the framework's secondary functions is classifying posts. The framework includes a working classifier, which can be tailored to specific classification schemes. In our initial tests, it was tailored to Bloom's taxonomy of knowledge. More specific classification schemes around research skills and/or employability skills will be considered in future work.
The framework is primarily intended to extract student posts and to analyse those posts for evidence of skills development as a student progresses through their studies. By tracking students' postings across different modules, we can assess who has studied which module and in what order for any potential effects. The framework also allows us to map forum usage during module presentation to the module calendar and thereby inform the presentation team as to the overall contribution of the forum to the module.
The framework is described in detail in a companion report.

6 Discussion and Conclusion

In this section we summarise what we have achieved in this project, reflect on some of the lessons leant, and outline future scholarship and research needed.

6.1 Achievement against objectives

A first main project objective was to compare and contrast contextualisations of the pedagogy across modules. This objective was fully achieved with the outcomes of our analysis summarised in Sections 2. It is interesting to note the subtle differences in interpretation of the pedagogy by the different modules and related implementations, and how subsequent adjustments were made as a result of feedback from year-on-year presentations. It is also

important to note this project was able to surface and share good practices, which have already influenced further adjustments across the modules. The latter has also contributed to meeting another project objective – that of identifying opportunities for sharing resources and practices.

Another project objective concerned quantifying impact of the pedagogy on module teams' and tutors' workload and practices. In terms of central staff workload and overall financial contribution the modules under study appear to perform better than their comparator M812 and M814, which adopt a traditional pedagogy, and are in line with M815, which adopts a situated learning pedagogy. The salary band for marking the assignment is the same as for all the other modules (with the exception of M812, which has a higher band due to some extra online activities). However, at least anecdotally, associated lecturers have reported that marking assignments is more demanding for them, although also more rewarding.

The more challenging project objective was to quantify effects though pathways on students' performance, satisfaction and retention, particularly for students who have completed multiple modules. Such an objectives was broken down into the further sub-objectives, which we describe next.

Firstly, we had to identify a selection of relevant quantitative and qualitative data, including specific student journeys as representative case studies: this was completely discharged as reported in Sections 3. Data included both standard KPIs around registration, retention, progression and students satisfaction, etc., as well as identification of 'student journeys' through the qualification, and qualitative data sets from module fora and students' assignments. We also identified appropriate comparators modules for benchmarking (see Section 2)

Next, we performed an in-depth analysis of the quantitative data (see Section 4). Briefly, the modules under study performs at least as well as the comparators in terms of students' attainment and satisfaction, but retention appears to be lower. Possible reasons have been considered, which have already triggered further investigation and pedagogical adjustments aimed at improving students' retention: the outcome will be monitored in future module presentations.

In parallel to the quantitative data analysis, we turned our attention to the qualitative data sets. It became soon apparent, however, that the amount of available data would have been prohibitively time consuming to analyse manually, and even manual sampling would have been unachievable with the project timescale. We therefore looked for more creative ways to tackle the problem and engaged a contract researcher to develop semi-automated tools for data selection, extraction and classification, based on Natural Language Processing (NLP) techniques. A proof-of-concept framework was developed (see Section 5 and tested on a data set consisting of module forum posts. The intention was then to follow this activity up with

a manual analysis of the extracted data, something we were unable to accomplish within the timeframe of the project.
Intermediate results were shared via seminar to the SEAT research group in the School of Computing and Communications (September, 2016). Final outcomes will be presented to the upcoming OU eSTEeM conference (April, 2017). We have also submitted an abstract to the Horizons in STEM Higher Education Conference 2017 (June 2017) and are awaiting outcomes.

6.2 Lessons learnt

Although most of the project objectives were met, early in the project it became apparent that the effort required for a manual qualitative analysis of the available data would have been disproportionate to the intended scope and amount of resource available for the project. Therefore, instead of attempting a partial qualitative analysis, we decided to devote our attention to the development of a semi-automatic framework able to increase the efficiency of future manual analysis quite significantly. This is a departure from the initially envisaged project approach, but one we feel has led to a very positive and promising outcome.
It came also as a surprise to us how difficult it was to access the data sets of interest. While within the OU we seem awash with management information and data analytics based on individual modules, there appear to be no automatic tools to extract data for comparisons between modules. Moreover, data are not consolidated in an easy-to-access data warehouse. Instead, for this project data had to be extracted manually from a variety of systems, often requiring lengthy process to identify stakeholders with the authority to access such systems. We feel this should be a lesson for the institution: better processes and tool support for data extraction should be put in place to facilitate this type of scholarship. It is certainly the case that precious time was wasted on this project due to the overhead of locating and accessing the raw data.

6.3 Future work

Overall, we think that the combination of techniques we have developed and applied to identify, extract and analyse data for this project can be seen as contributing to an overall evaluation framework, which could be used not just for this project, but in general for studies of a similar nature. That said, the framework still needs adjusting and evaluating, so that further work is required. In particular, this research will benefit from a follow-up project, whose specific objectives may include:

- incorporate new quantitative data from more recent module presentations, and data from other modules used as benchmarks
- expand the range of qualitative data sets to include open ended answers in survey data and student assignments, including aggregating data for specific student journeys through the qualification, to be used as representative case studies
- customize the classification and selection scheme used by the semi-automated techniques to the range of research and employability skills under consideration
- apply the customized framework to the new data sets
- measure the accuracy of precision and recall
- establish the wider applicability of the framework

Outcomes from this new project will provide an evidence-based framework with direct benefits to the teams of the modules under study, for further development and fine-tuning of the pedagogical approach, as well as to other module teams wanting to implement or capitalise on the pedagogical approach, or perform similar analysis on different pedagogy. Moreover, they could also help qualification leads, as part of wider qualifications assessments.

A Research Teaching Structure

A.1 M811

M811's READ teaching consists of four hours of activities:

```
Activity 1: Using the OU Library resources
Activity 2: Starting your M811 bibliographic database
Activity 3: Searching for a paper
Activity 4: Using annotations
Activity 5: Applying the five Cs
Activity 6: Conducting a second pass
Activity 7: Conducting a third pass (optional)
Activity 8: Adding notes to your BDMS
Activity 9: Expanding your BDMS
Activity 10: Further research
```

M811's SUMM teaching consists of six hours of work, structured by the following activities:

```
Activity 1: Expert summary: machine or human?
Activity 2: An example of a summary
Activity 3: Summarising Anderson (2001a)
Activity 4: Creating your summary article
Activity 5: Summarising Schneier (2007)
Activity 6: Comparing and contrasting two articles
```

M811's CRIT teaching consists of six hours of work, structured by the following activities:

```
Activity 1: Reflecting on previous work
Activity 2: Knowledge, scholarship and research
Activity 3: Being critical
Activity 4: Investigating bad science
Activity 5: Identifying issues
Activity 6: Analysing a conclusion
Activity 7: Practical vulnerability identification.
```

A.2 M813

M813's READ teaching is similar to M811's, again with 10 activities.

A.3 M816

M816's READ teaching is similar to that of M811 and M813, again structure around 10 activities.

A Students survey data

KPIs	M811	M813	M816	mean	M812	M814	M815	mean
	response	response	response		response	response	response	
	13K 38%	14E 35%	14K 39%		14E 43%	14K 32%	14E 36%	
	14K 33%	15E 23%	15K 28%		15E 42%	15K 36%	15E 33%	
	15K 38%	16E 22%			16E 33%		16E 28%	
				32%				35%
1. Overall, I am satisfied with the quality of this module.	13K 68%	14E 83%	14K 56%		14E 93%	14K 81%	14E 95%	
	14K 55%	15E 91%	15K 67%		15E 56%	15K 80%	15E 96%	
	15K 85%	16E 94%			16E 29%		16E 83%	
				75%				77%
2. Overall, I am satisfied with my study	13K 56%	14E 79%	14K 63%		14E 83%	14K 75%	14E 84%	
	14K 51%	15E 86%	15K 57%		15E 56%	15K 84%	15E 86%	
	15K 85%	16E 95%			16E 32%		16E 85%	
				72%				73%
3. The module provided good value for money.	13K 48%	14E 57%	14K 45%		14E 58%	14K 53%	14E 70%	
	14K 31%	15E 67%	15K 40%		15E 45%	15K 63%	15E 75%	
	15K 80%	16E 61%			16E 26%		16E 66%	
				54%				57%
4. Overall, I was satisfied with the teaching materials provided on this module.	13K 52%	14E 69%	14K 48%		14E 83%	14K 69%	14E 82%	
	14K 52%	15E 86%	15K 52%		15E 38%	15K 68%	15E 89%	
	15K 80%	16E 88%			16E 18%		16E 72%	
				66%				65%
5. Overall, I was able to keep up with the workload on this module.	13K 64%	14E 76%	14K 78%		14E 62%	14K 69%	14E 76%	
	14K 67%	15E 86%	15K 76%		15E 63%	15K 72%	15E 77%	
	15K 79%	16E 94%			16E 54%		16E 85%	
				78%				70%
6. The learning outcomes of the module were clearly stated.	13K 76%	14E 90%	14K 78%		14E 86%	14K 88%	14E 92%	
	14K 74%	15E 100%	15K 81%		15E 88%	15K 100%	15E 97%	
	15K 89%	16E 100%			16E 68%		16E 89%	
				86%				89%
7. I would recommend this module to other students.	13K 63%	14E 72%	14K 56%		14E 83%	14K 69%	14E 87%	
	14K 37%	15E 86%	15K 57%		15E 53%	15K 79%	15E 93%	
	15K 74%	16E 95%			16E 30%		16E 77%	
				80%				71%
8. The module met my expectations.	13K 56%	14E 79%	14K 53%		14E 86%	14K 75%	14E 86%	
	14K 44%	15E 86%	15K 50%		15E 56%	15K 74%	15E 90%	
	15K 76%	16E 89%			16E 29%		16E 83%	
				67%				72%
9. I enjoyed studying this module.	13K 56%	14E 72%	14K 53%		14E 97%	14K 62%	14E 89%	
	14K 48%	15E 86%	15K 57%		15E 63%	15K 74%	15E 90%	
	15K 84%	16E 90%			16E 46%		16E 87%	
				68%				76%
10. I was satisfied with the support provided by my tutor on this module.	13K 72%	14E 96%	14K 74%		14E 96%	14K 88%	14E 89%	
	14K 74%	15E 100%	15K 100%		15E 91%	15K 84%	15E 94%	
	15K 97%	16E 100%			16E 73%		16E 100%	
				89%				89%

Figure 9: Students survey data

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