Full paper

Core Content for a Collaborative NZ ITP Computing/IT Degree

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Abstract

Computing qualifications offered at New Zealand Institutes of Technology and Polytechnics (ITPs) have changed in the last decade. Ten years ago, most ITPs offered certificates and/or diplomas in Computing. Several of these had become national qualifications backed by the National Advisory Committee for Computing Qualifications (NACCQ) which enabled students to transfer between institutions and continue with the same qualification. Employers were aware of the value of each of these qualifications. More recently, however, many ITPs have developed computing degrees, some as stand-alone degrees and others as degrees taught via franchise arrangements. Consequently, the NACCQ developed a national moderation framework to ensure uniformity of standards across these various degrees. A logical extension to this was the development of a national collaborative ITP computing degree, an idea that has been mooted for several years. Much background work has already been completed for this. In conjunction with the background work, all New Zealand ITPs were asked to provide a list of core Computing/Information Technology (IT) degree courses and their associated learning outcomes. These were analysed and reduced to a set of core topics at each of Level 5, 6 and 7, which enabled commonly taught compulsory content to be discerned. A triangulation was then achieved informing participants of the previous results and asking for their preferences regarding a set of core topics for the proposed collaborative degree. Further discussion is needed, but to ignite this, some possibilities are raised

1 Introduction

The NACCQ has, over a number of years, been considering the creation of a national collaborative Computing and/or Information Technology degree for Institutes of Technology and Polytechnics (ITPs) in New Zealand. Fifteen of the seventeen ITPs have agreed in principle to take up this degree when it has been established.

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All ITPs are currently members of the NACCQ and this organisation has an infrastructure, which could be adapted to include a collaborative degree along with other existing supported qualifications. This infrastructure allows members to share the load of keeping content current, and of a consistent quality across the sector. ITPs offering the same degree, across the sector, will give members the above benefits and also allow the qualification portability for students and give industry a clear benchmark for comparison throughout New Zealand.

The curriculum area covered by the two domains, Computing and IT comprise of a wide continuum from Computer Science (CS), on the one extreme, through IT to Information Systems (IS) at the other extreme (Finkelstein and Hafner). Some ITPs specialise at a particular place along this continuum whilst others attempt to encompass the entire range of topics. There is, nevertheless, a central core of topics which are essential to any computing degree and these core areas are explored in this paper.

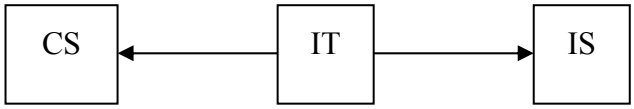

Figure 1: The CS/IS continuum

2 Background

The NACCQ was founded in 1988. Its membership includes the information and communication technologies departments of all polytechnics, institutes of technology and selected universities in New Zealand. (See Appendix A, NACCQ Background, for further information).

The 'Blue Book' (Roberton) and the website www.NACCQ.ac.nz contain the regulations which govern the national qualifications, Certificate in Computing Level 3, Diplomas in Information and Communications Technology Levels 5 and 6 (DipICT5 and DipICT6) and the National Diploma in Business Computing (NDBC Level 7). In total the NACCQ supports more than 150 courses and national moderation systems for all of these courses. Each course is supported by a Special Interest Groups (SIG), representing a particular curriculum area, led by a designated SIG leader. SIGs provide NACCQ sector members with a forum through which they can contribute ideas for new

courses as well as maintain the academic currency of the existing courses.

Over the last ten years many ITPs have established their own degrees or have franchised them from other institutes. Typical degree titles are Bachelor of Computing Systems (BCS), Bachelor of Information Technology (BIT) and Bachelor of Information and Communications Technology (BICT). The NACCQ has supported these developments by helping emerging researchers at their annual conference and by establishing an online journal, BACIT, in which researchers' papers can be published. Citrus, a bulletin for IT research, is also available. Further support for the various degrees was the establishment of a national degree moderation facility in 2004.

Since that time various negotiations have taken place and ITPQ has expressed support for the concept of a collaborative computing/IT degree for New Zealand's ITPs. It was against this background that the author decided to research the existing core content within computing/IT degrees, currently offered by New Zealand's ITPs, with a view to informing the parties involved in this collaboration.

3 Research Procedures

3.1.1 Data Collection

New Zealand ITPs were approached by way of a personal email to the representative listed on the NACCQ Member Institution Contact List. Universities were not included and neither were the two polytechnics who currently do not have a computing degree. Each participant was asked to provide a list of core compulsory courses in their computing or IT degree and a list of learning outcomes expected for each of these courses. The email explained that the data would be analysed and results would help to inform a new collaborative computing/IT degree which is being supported by the NACCQ.

Nine institutions returned the data in full and others either returned partial data, such as the list of courses with no learning outcomes, and some returned no data at all.. The data returned was supplemented by searching the websites of the institutions. This resulted in a datasets from two more institutions comprising just the core paper titles and aims, and three institutions comprising only titles of core courses. In all data from fourteen institutions are represented in this paper.

3.1.2 Data Reduction

All data were categorical which means that although they were treated quantitatively in order to generate descriptive statistics, the process of labelling data items relied upon an interpretive, or qualitative approach being used. The learning outcome data were amalgamated but sorted into three sections, separating out Levels 5, 6 and 7. The titles and, aims, of the courses at the other five institutes were merged in these three documents. As a result, a set of categories at each level was established and each learning outcome was assigned to one of those levels by topic. Some learning outcomes, whilst important, were judged to be not specific to a particular curriculum area, and so they were categorised as outrider topics. An example of an outrider or small topic was Ethics and Security which appeared in various differently entitled courses, but it should be emphasised that just because such an item appeared as an outrider topic, does not mean that it is not important in the scheme of things.

The topic dataset that was assembled was very large because it was populated by many and varied descriptors which were to be analysed with the intention of reducing them to a smaller, workable, list of learning outcomes that could be associated with each topic. This proved to be a complex task and was ultimately deemed to be unnecessary as it became obvious that a combination of topic titles and course names could convey enough details to allow a working party to re-generate revised, reworded or merged learning outcomes as and when this becomes necessary in the creation of new courses for the collaborative degree.

3.1.3 Phase A Findings

The tables, below, show the number of ITPs currently offering each topic, as a compulsory component, at the various levels:

Table 1: Current Compulsory Topics at Level 7

Level	Topics	Number of ITPs	% of ITPs
7	Project	11	78%
7	Management Information Systems	3	21%
7	Project Management	2	14%
7	Database Management Systems	1	7%

Table 2: Current Compulsory Topics at Level 6

Level	Topics	Number of ITPs	Out of 14 ITPs
6	Systems Analysis and Design	11	78%
6	Project Management	7	50%
6	Data Communications and Networks	2	14%
6	Website Development	2	14%
6	Programming	1	7%
6	Information Systems and Business/Society	1	7%
6	Collaborative Technologies	1	7%
6	Communication Studies	1	7%
6	Electronic Commerce	1	7%
6	System Modelling	1	7%

Table 3: Current Compulsory Topics at Level 5

Level	Topics	Number of ITPs	Out of 14 ITPs
5	Introductory Programming	13	93%
5	Communications	12	86%
5	Networks	12	86%
5	Information Systems & Business Practice	8	57%
5	Hardware	8	57%
5	Data and Databases	7	50%
5	Intermediate Programming	7	50%
5	Operating Systems	7	50%
5	Computing Basics and Packages	6	43%
5	Ethics and cultural issues	6	43%
5	Mathematics	5	36%
5	Statistics	3	21%
5	History of Computing	2	14%
5	Electronics	1	7%
5	Multimedia	1	7%
5	Object Oriented Principles	1	7%
5	Systems Analysis and Design	1	7%
5	Web Design	1	7%

3.1.4 Phase A Discussion

Of the 14 ITPs surveyed, 5 had a base unit of 20 credits, 3 had 18 credits and 6 had 15 credits. Waiariki (currently 18 credits) is keen to have all courses standardised at 15 credits and it is understood that several more ITPs are heading the same way. It would then seem logical, for the new collaborative degree to standardise with 15 credits.

As may have been expected, an industry Project at Level 7 is core for most degrees, with many offering this as a double or even triple course, Systems Analysis and Design at Level 6 and Communications, Introductory Programming, and Networks at Level 5 were also core for the vast majority of ITP degrees. Project Management appeared in either Level 6 or 7 for most ITPs and only one ITP had Systems Analysis and Design scheduled at Level 5.

The Level 6 outliers are rather diverse. A logical conclusion, about whether they should be adopted for a collaborative degree, is to suggest that they should be delivered as options.

Most ITPs seem to have a fairly basic course in database at level 5 – with only one degree (3 ITPs) mentioning SQL in the learning outcomes. Use of the phrase 'Computing Fundamentals' is quite common and seems to represent a combination of topics including packages, hardware, data storage, information systems and ethics. Computing basics (or fundamentals) and packages were core content at Level 5 for six ITPs. Here arises a discussion point for future development of the collaborative degree. It could be argued that as school leavers and the general population become more computer literate, perhaps application packages might be a subject that should now be offered as an option or covered in Level 4. Are application packages really a degree level subject? There is a counter argument that computing students need to be 'super users' and that this can be assured by putting all students through such a course at Level 5. There is merit in both of these arguments and the matter certainly warrants further discussion.

At Level 5 information systems in business, hardware and operating systems, data and databases and intermediate programming were also often compulsory. This would indicate that they should be contenders for core topics in the collaborative degree.

A variety of mathematical topics and statistics were also core in some degrees at level 5. These may reflect the position that the degree takes along the computer science, information systems (CS/IS) continuum. The majority of ITPs, however, do not make mathematics compulsory.

The topics that only occur once on the 'Topics' table could be considered as outliers and hence be disregarded, they might indicate that either an ITP was lagging behind the average or ahead of the play, alternatively they may indicate a bias somewhere along the CS/IS continuum. At least they should be considered by a working party before removing them from any core considerations list. These questions arise:

- Web design or, at least, basic web development could be considered a core attribute for a computing professional. Only one ITP has this as a compulsory topic at level 5 and two at Level 6. Should this topic become compulsory in a new degree?
- In a similar vein it could also be argued that manipulation of multimedia elements might be considered as a core skill for tomorrow's ICT professionals. Does this make it a candidate for consideration as a core component?
- Two ITPS included topics on the history of computing and several more included the history of the Internet. Do all our students still need to review this history or is it time to drop these topics and move on?

3.2 Phase B Triangulation Findings

A report was then sent to all participants detailing the research procedures and results of the survey, as described above. Two months later, each participant was asked to complete a questionnaire relating to the proposed

collaborative computing degree. The questionnaire was based on the list of core topics in Tables 1,2 and 3 (see Appendix B). Participants were asked to indicate their preferred set of core topics, at Levels 5, 6 and 7. In addition to these, there was room for any participant to add topics and a section was also created to allow for participants comments. Nine responses to this questionnaire were received and these were combined to produce Tables 4, 5 and 6. These tables show the number of ITP representatives who indicated a preference for particular topics, as compulsory components at each level. Clearly states the research question and the background to the problem being researched and its relevance to the conference audience.

Table 4: Participant Selected Topics for Level 7

Level	Topics	✓	% of Respondents
7	Project – industry client	9	100%
7	Management Information Systems	2	22%
7	Project Management	3	33%
7	Database Management Systems	1	11%
7	Other	1	11%

Table 5: Participant Selected Topics for Level 6

Level	Topics	✓	% of Respondents
6	Systems Analysis and Design	8	88%
6	Project Management	8	88%
6	Data Communications and Networks	4	44%
6	Website Development	4	44%
6	Programming	4	44%
6	Information Systems and Business/Society	3	44%
6	Collaborative Technologies	2	22%
6	Communication Studies	3	33%
6	Electronic Commerce	3	33%
6	System Modelling	3	33%
6	Other		

Table 6: Participant Selected Topics for Level 5

Level	Topics	✓	% of Respondents
5	Introductory Programming	9	100%
5	Communications	8	88%
5	Networks	7	77%
5	Information Systems & Business Practice	7	77%
5	Hardware	7	77%
5	Data and Databases	8	88%
5	Intermediate Programming	3	33%
5	Operating Systems	7	77%
5	Computing Basics and Packages	5	55%
5	Ethics and cultural issues	7	77%
5	Mathematics	5	55%
5	Statistics	2	22%
5	History of Computing	1	11%
5	Electronics	1	11%
5	Multimedia	5	55%
5	Object Oriented Principles	3	33%
5	Systems Analysis and Design	4	44%
5	Web Design	4	44%
5	Wellness and work/life balance	1	11%
5	Telephony and mobile technology	1	11%
5	Other		

3.3 Phase B Discussion of Triangulation

There is a fair degree of consensus throughout the computing fraternity that there are core skills required of computing professionals. Looking at the core components of New Zealand ITP Computing/IT degrees there are many similarities and much core content that would not be disputed.

However, there are still a few questions still to be debated.

- *Do all students need to pass a Mathematics course in their computing degree? If so what are the essential topics?*

- *Is a course on applications at Level 5 a core essential?*
- *Are Web design/development skills and possibly multimedia element processing expected of all today's computing professionals?*

Relevant parties then need to look outside what we has already been included and to debate whether there are additional core skills or topics that do not fall under one of the above headings. For example telephony does not seem to figure in any of our degrees, neither does mobile technology.

- *Do students need to know about what is happening in the rest of the world and how to deal with other cultures in our own country?*

Bearing in mind the frequent 'burn out' rate among computing professionals

- *Should all our students do some work on wellness and basic health studies, such as 'the corporate athlete', along with their communications and soft skills education?*
- *Do they need to learn about home/work balance?*
- *Do ITPs owe it to their students to give them the skills to keep fit and well in their corporate lives?*

4 ACM and IEEE-CS Guidelines and Overseas Models

Looking to overseas experience and guidelines could help in this decision making. Which core topics are globally accepted as important for computing undergraduates? The Association for Computing Machinery (ACM), with the Institute of Electrical and Electronic Engineers (IEEE) Computer Society (IEEE-CS), is currently reshaping its guidelines for undergraduate curricula in the five distinct disciplines in computing as they see them, Computer Engineering (CE), Software Engineering (SE) and CS, IT and IS, as previously described. Of most interest here is the 2008 draft of the "Information Technology Volume of Computing Curricula". Table 7 shows the topics that this draft report recommends as core for undergraduate IT students.

The recommendations assume a four year degree, but content can still be usefully compared with the core content tables 5, 6 and 7 above. It is interesting to note that at Year 1 there is no mention of Mathematics or Statistics, although the ACM "Overview Report" of 2005 (Shackleford et al) notes that Mathematics underpins all five computing disciplines. Another point of interest is that while we, in New Zealand, have mostly purged the History of Computing from our computing degrees, it is still mentioned here as core.

At higher levels, the inclusion of Human Computer Interaction and Information (HCI)

Assurance and Security is of interest and certainly worthy of discussion. These two topics are also missing in the Indian, All Indian Council for Technical Education (AICTE) curriculum (Joseph et al). The appearance of Communications in Year 3 and Ethics in Year 4 is different from the New Zealand norm which tends to teach these topics in the first year. Experience in UK has been similar with Communications courses appearing, in some institutes, at each level of study.

Table 6: Participant Selected Topics for Level 5

Year	Topic	Content
1	IT Fundamentals	Introduces students to the academic discipline of IT. Pervasive IT themes; IT history; Organizational issues; Relationship of IT to other computing disciplines
1	Programming Fundamentals	Introduces students to the basics of programming, including data structures, programming constructs, object-oriented programming, algorithms and problem solving, event-driven programming, and recursion.
1	Computing Platforms	Principles of computer hardware and low-level software, including logic circuits, assembly language, I/O, storage, program execution; Basics of computer operating systems, including configuration, file systems, security, administration, interfacing, multitasking, performance analysis
2	IT Systems	Introduction to the basic components of IT systems, including networking, web systems, databases, scripting, system administration and maintenance, and system integration
2	Web Systems	Introduction to web technologies and systems, including hypertext, self-descriptive text, web page

		design, web navigational systems, database integration and digital media.
3	Networking	Builds a deeper understanding of how networks work, including the topics of LANs, WANs, service providers, packets, hubs, routers, switches, Internet protocols.
3	Databases	Builds a deeper understanding of how databases work, including the topics of database theory and architecture, data modeling, normalization, query languages, security, and Web applications.
3	Human-Computer Interaction	Introduction to the basic concepts of human-computer interaction, including human factors, performance analysis, cognitive processing, usability studies, environment, and training.
3	Technical and Professional Communication	Introduction to written and oral technical and professional communication, including proposals, reports, presentations, formal papers.
4	Information Assurance & Security	Introduction to the concepts of data security, including policies, attacks, vulnerabilities, encryption, information states, and forensics
4	• IT Capstone I • IT Capstone II	• IT senior project-first semester, including project proposal, feasibility studies, intellectual property, teamwork, budgets, schedule management • IT senior project-second semester, including teamwork, professional communications (reports and presentations), design implementation, testing.

5 Concluding Comments

There was not a great deal of difference between the current core content in New Zealand ITP computing degrees and the content that was suggested for a new collaborative degree. In comparing the New Zealand choices for core content with ACM recommendations and overseas curricula it becomes evident that some thought should be given to instigating some changes and perhaps the introduction of new areas of study.

6 Recommendations

Recommendations for core topics for the new ITP collaborative Computing/IT degree are straightforward at levels 7 and 6 and include the following:

1. Level 7:

That Project be included as a compulsory course with double or triple credit value. Assuming a base credit value of 15, this would make project a 30 or 45 credit course.

2. Level 6:

That Systems Analysis And Design and Project Management are both included as compulsory courses..

The reason for including Project Management at Level 6 is that it is an obvious pre-requisite for level 7 Project.

3. Level 5

That Introductory Programming, Networks, Hardware and Operating Systems, Information Systems in Business and Data and Databases are included as compulsory courses.

4. That Ethics and some bi-cultural content be included within compulsory courses.

5. The a Communications course be compulsory at some level of the degree.

6. That standard courses in the new degree be worth 15 credits.

7. That the inclusion of some compulsory topics in HCI and Assurance and Security be debated.

7 References

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8 Appendix A

8.1.1 NACCQ Background

"The National Advisory Committee on Computing Qualifications (NACCQ) was founded in 1988 as a result of a review of the national qualifications in data processing and information technology.

The NACCQ sector includes the information and communication technologies departments of all polytechnics, institutes of technology and selected universities in the country. The executive committee consists of elected representatives of the academic sector and a strong representation from the information and communication technologies industry. This structure reinforces the goals of the NACCQ to work hand in hand with industry to develop and deliver current marketable qualifications that are industry focussed and to ensure that students are work ready when they graduate.

The National Advisory Committee on Computing Qualifications is set up:

To offer support and advice to ITP NZ and the NACCQ sector in relation to the field of Computing and Information Technology.

To negotiate with the appropriate Government agencies on issues relating to the field of Computing and Information Technology.

To co-ordinate information relating to the field of Computing and Information Technology.

To promote the teaching, learning, research and development in the field of Computing and Information Technology.

To co-ordinate the partnership of Industry and the NACCQ sector in the field of Computing and Information Technology.

To maintain a high quality of graduates for industry in the field of Computing and Information Technology.

To contribute (on behalf of the NACCQ sector) to the development of prescriptions for vocational computing and information technology courses in New Zealand.

To contribute (on behalf of the NACCQ sector) to the maintenance of the relevance of developed courses to meet the changing requirements of the New Zealand Computer and Information Technology industry by suggesting timely changes to course prescriptions in response to industry developments. A full review of all programmes to be carried out at least every two years

To provide a central support for training providers offering these programmes.

To liaise with the New Zealand Qualifications Authority (NZQA) and other relevant national bodies (e.g the New Zealand Computer Society) over national issues relating to these courses (e.g course approval, accreditation, moderation, assessment, professional registration, etc) in conjunction with ITP NZ.

To support the availability of a full range of vertically integrated vocational computing qualifications for New Zealand.

To ensure cooperation and effective communication between industry and training providers is achieved.

To offer guidance and advice on programme management.

To co-ordinate the development of resources for the use of academic staff.

To encourage national and international recognition of the qualifications."

NACCQ Background. (2007). Retreived October 30 2007, from

http://www.naccq.ac.nz/index.html?page=2

9 Appendix B: Questionnaire

NACCQ Proposed Collaborative Degree – Core Content Questionnaire

Responses to this questionnaire will be used to inform a paper to be presented at the Auckland NACCQ conference in July 2008. The source of expressed opinion will not be quoted directly and no participants or their institutes will be named.

- Please indicate with a '✓' the topics that you/your institute would want to see as compulsory in a collaborative degree.
- Add any other topics that you feel should be core for all participating institutes.
- Your comments would also be appreciated.

The following topics do not necessarily constitute a whole course but may be included as part of a course.

Topics at Level 5

Level	Topics	✓
5	Introductory Programming	
5	Communications	
5	Networks	
5	Information Systems & Business Practice	
5	Hardware	
5	Data and Databases	
5	Intermediate Programming	
5	Operating Systems	
5	Computing Basics and Packages	
5	Ethics and cultural issues	
5	Mathematics	
5	Statistics	
5	History of Computing	
5	Electronics	
5	Multimedia	
5	Object Oriented Principles	
5	Systems Analysis and Design	
5	Web Design	
5	Wellness and work/life balance	
5	Telephony and mobile technology	
5	Other - specify	
Comments		

Topics at Level 6

Level	Topics	✓
6	Systems Analysis and Design	
6	Project Management	
6	Data Communications and Networks	
6	Website Development	
6	Programming	
6	Information Systems and Business/Society	
6	Collaborative Technologies	
6	Communication Studies	
6	Electronic Commerce	
6	System Modelling	
6	Other - specify	
Comments		

Topics at Level 7

Level	Topics	✓
7	Project – industry client	
7	Management Information Systems	
7	Project Management	
7	Database Management Systems	
7	Other - specify	
Comments		

10 Glossary

CS Computer Science

IS Information Systems

IT Information Technology

SE Software Engineering

CE Computer engineering

ITP Institute of Technology and/or Polytechnic

NACCQ National Advisory Committee on Computing Qualifications

ACM Association for Computing Machinery

IEEE Institute of Electrical and Electronic Engineers