Concise paper

FITNZ - Graduate profiles for ICT education at senior secondary level

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ABSTRACT

This paper proposes a set of curriculum models for ICT education at the senior secondary school level in New Zealand. These models arise from the Fluency in IT ("FITNZ Project"), a collaborative venture between tertiary and secondary sector educators, government and industry. The initiative is intended to address the poor alignment between tertiary education and the IT needs of the industry sector. The confused perceptions of ICT and the fragmented and uneven state of computing education at the secondary level have contributed to the disparity between tertiary education and industry needs. The paper draws on previous work on IT fluency by Larry Snyder. It also positions the computing disciplines within the ACM computing curricula 2004 document in order to propose a soundly based set of graduate outcomes.

Keywords

I T Fluency, IT Education, computing curriculum, High School Computing curricula.

1. INTRODUCTION

1.1 The "FITNZ" Project

This paper proposes a set of curriculum models for ICT education at the senior secondary school level in New Zealand. These models arise from the "FITNZ Project" a collaborative venture between tertiary and secondary sector educators, government and industry. For some time increasing concern has been expressed by a number of key computing industry multinationals about the falling applications for computing courses against the growing industry demand for graduates. As at March 2004 most of these organisations had committed themselves to the FITNZ project, now sponsored by E-Regions (Pullar-Strecker, 2005), in an attempt to develop a solution. The aim was to raise $500,000 in support of the project, with the Government committing itself to contributing an equal amount. The initiative was endorsed by the NACCQ executive at a meeting in March 2004. It is hoped that the project will lead to better alignment between the needs and expectations of industry employers and the tertiary sector.

2. A TYPOLOGY OF THE COMPUTING DISCIPLINES

In their recent report on the computing curricula, Shackleford *et al.*, (2004) portray the US experience in the development of the academic computing disciplines. From earlier perspectives of electrical engineering and computer science as cognate disciplines and Information systems as quite divergent, a distinct grouping of six disciplines is now emerging. Figure 1 from the Shackleford report depicts this grouping. Of these, electrical engineering could be excluded as not a true computing discipline, but the remaining five could be considered as computing related disciplines, each with a distinct but somewhat related focus.

The complexity and rapid development of computing and accompanying professional practices makes it a difficult set of disciplines to understand and explain to students, parents, teachers and others not directly involved in the field. In fact, debate has even raged within the academic community for years (Denning, 2005) as to whether Computer Science is actually science. Broader terms such as "Information Technology" and "Information and Communications Technology" have arisen to better reflect the breadth of these disciplines as they are understood by the IT industry and educators. Generally though,

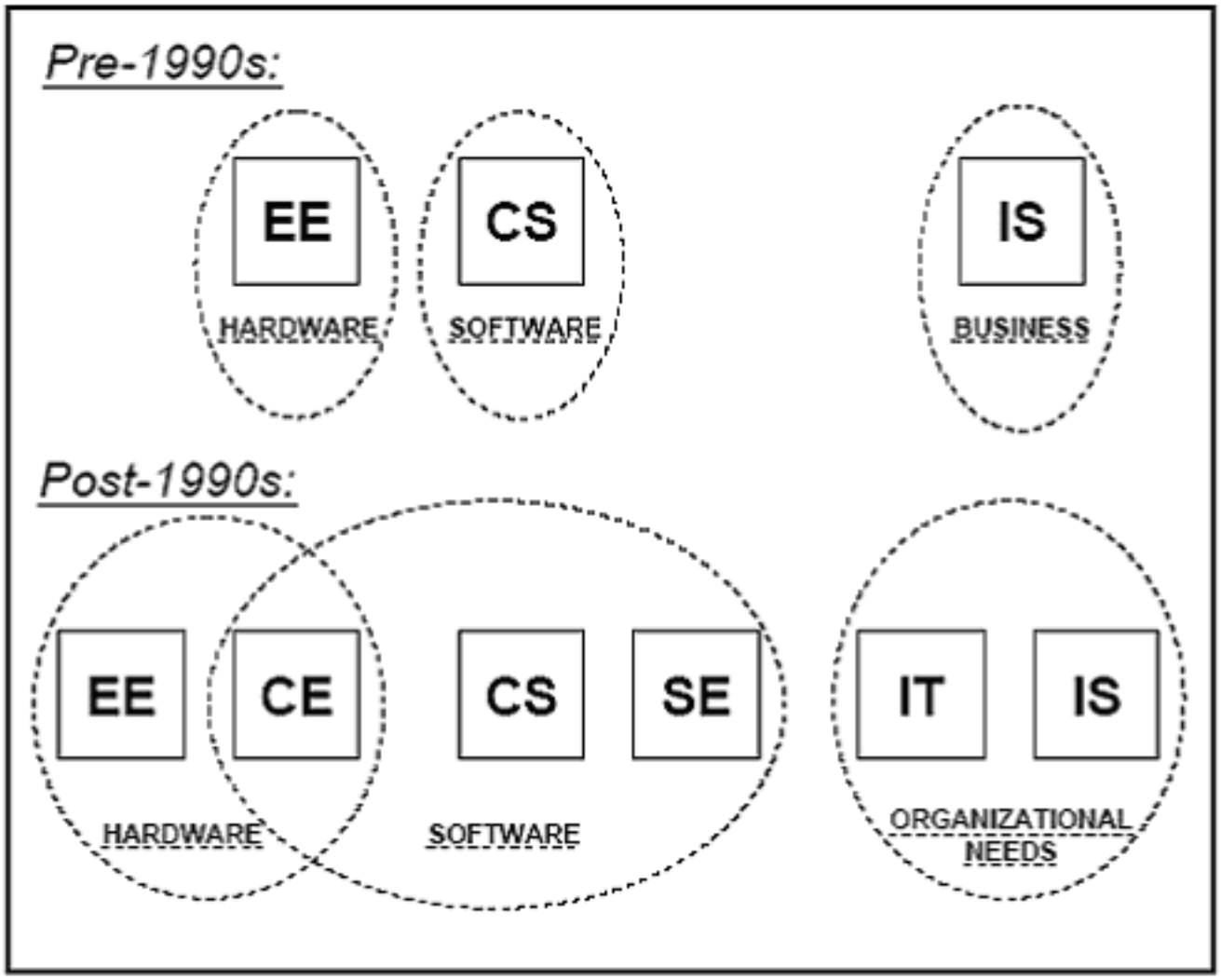

Figure 1: The computing disciplines, before and after the 1990s (from Shackleton 2004 Figure 2.2)

there seems to be widespread confusion about the nature and scope of the computing disciplines.

Regardless of the chosen name it is clear that there is significant demand for individuals with computing knowledge and qualifications. There are compelling reasons to develop a curriculum which properly reflects and does justice to this breadth of requirements.

In general, many current efforts at senior secondary school level either capture one small segment of the discipline family and claim it as computing or ICT, or provide a "mishmash" of unrelated elements and believe that coverage has been achieved.

It is worth noting that the current teaching of end-user applications in schools, (word processing and spreadsheets etc.) or what might be considered knowledge worker productivity tools, are considered academically at most as a very minor subset of the Information Systems discipline and probably more aptly as a set of tools required and used by all disciplines, not just the computing disciplines.

3. IT FLUENCY

The ability to make use of IT is known as "Fluency with IT" (FIT), a broader conception than IT Literacy. Recent work by Snyder *et al.*, (1999), Snyder (2003) and Dougherty Clear *et al.*, (2003) has stressed the importance of fluency with Information Technology (IT) for full participation in today's society. IT Fluency does not solely emphasize information manipulation, knowledge worker productivity tools or the skills dimensions of ICT. The latter two skills are often seen in applications based curricula such as the use of desktop applications (word processors, spreadsheets or presentation tools),

or certifications such as the Microsoft MOUS qualification. Nor does IT Fluency encompass only the conceptual dimensions of computing as some of the more theoretical and mathematically oriented computing curricula may do.

The elements of the IT Fluency Model are:

- Contemporary skills
- Foundation concepts
- Intellectual capabilities

Dougherty, *et al.*, (2003) have defined these three components (representing complementary and necessary forms of knowledge) as follows:

- Contemporary skills are needed for job readiness, and provide practical experience on which to build new competence.
- Foundation concepts are the "raw material" for understanding IT as it evolves, giving insight into the potential and limits of IT.
- Intellectual capabilities encourage abstract reasoning about IT to empower a person to exploit IT when possible and recover from the problems using IT.

Each of these components in turn has been broken down into ten categories (Snyder, 1999), cf. component column in tables 1-3 below. The notion of "FITness" has been observed to be "personal (i.e., there is no universal benchmark for defining a single measurement for FITness), graduated (i.e., there are different levels of FITness, rather than just stating that an individual is or is not FIT), and dynamic (implying the need for lifelong learning as technology changes)" (Dougherty *et al*, 2003).

The table below broadly suggests required levels of achievement which can be operationalised within curriculum models. Use of the proposed curriculum would result in year 12 and 13 graduates of the senior secondary school system attaining a consistent and identifiable set of capabilities. The benefit of such a model is that this combination of conceptual knowledge, specific skills and broader intellectual capabilities would both reinforce, and in turn be reinforced, by other subjects in the high school curriculum.

4. ACHIEVEMENT LEVELS AND GRADUATE PROFILES – YEARS 12 AND 13

In broad terms two distinct profiles could be expected from the proposed framework:

- a graduate of a year 12 course of study in ICT would have been exposed to all aspects of the IT Fluency framework, and demonstrate at least a low level of capability sufficient to equip them for effective use of IT in their daily lives and future studies.
- at year 13 a graduate would be expected to demonstrate a moderate level of capability sufficient to equip them for effective use of IT in their daily lives and future studies and have a greater depth of expertise in two or more selected areas of ICT. This would equip them for higher study in a "computing related" discipline as delineated in 2 above.

The table below indicates the specific FITness components in which expertise would be demonstrated by a student.

Note: The achievement levels here reflect the NZQA levels 1 – 4 (NZQA, 2004) to indicate the depth of study in a particular aspect. Indicative hours of study may also be required, in a further expansion of this model to guide curriculum development.

5. PARTNERSHIP MODELS

The FITNZ project is a multi-party and cross sector initiative. It appears to represent the first occasion that a major coalition of computing industry, secondary and tertiary sector educators and government agencies have united to address the issues related to teaching computing in the secondary system. Individual linkages and partnerships already exist, but not on the scale of this project nor at a national level. Some examples of industry / educational partnership models are: NACCQ and CISCO in the delivery of joint curriculum (Roberton & Corbett, 2004); Microsoft and the NZQA in providing Microsoft certifications as a course of study registered for NCEA credit inclusion (Pascoe, 2003); the NZ and other computer societies in the offering of the International Computer Driving License and

Category – Intellectual Capabilities

Component	Suggested achievement levels	
	Year 12	Year 13
Engage in sustained reasoning	1,2	3,4
Manage complexity	1,2	3,4
Test a solution	1,2	3,4
Manage problems in faulty solutions	1,2	3,4
Organize and navigate information structures and evaluate information	1,2	3,4
Collaborate	1,2	3,4
Communicate to other audiences	1,2	3,4
Expect the unexpected	1,2	3,4
Anticipate changing technologies	1,2	3,4
Think about Information Technology abstractly	1,2	3,4

Table 1. Intellectual Capabilities

Category – Information Technology Concepts

Component	Suggested achievement levels	
	Year 12	Year 13
Computers	1,2	3,4
Information Systems	1,2	3,4
Networks	1,2	3,4
Digital Representation of Information	1,2	3,4
Information Organisation	1,2	3,4
Modeling and Abstraction	1,2	3,4
Algorithmic thinking and programming	1,2	3,4
Universality	1,2	3,4
Limitations of Information Technology	1,2	3,4
Societal impact of Information and Information Technology	1,2	3,4

Table 2. Information Technology Concepts

Category – Information Technology Skills

Component	Suggested achievement levels	
	Year 12	Year 13
Setting up a PC	1,2	3,4
Using basic operating system features	1,2	3,4
Using a word processor …	1,2	3,4
Using a graphics … to create image-based expressions of ideas	1,2	3,4
Connecting a computer to a network	1,2	3,4
Using the Internet to find information and resources	1,2	3,4
Using a computer to communicate with others	1,2	3,4
Using a spreadsheet …	1,2	3,4
Using a database system …	1,2	3,4
Using instructional materials to learn how to use new applications or features	1,2	3,4

Table 3. Information Technology Skills

European Computer Driving Licenses (NZCS, 2005). The Wellington College Tech Angels scheme (Kong, 2003, Dec 2004) links secondary female students with teachers, the tertiary and IT industry sectors; Manukau Institute of Technology and local secondary schools are providing NACCQ curriculum at high school level (Andrews, 2004); the Cyberwaka Enterprises Cisco Networking Academy Program (CNAP) a joint venture between the Bay of Plenty iwi and The Pacific Islands Matati E Fa Trust, based in Auckland (Te_Puni_Kokiri, 2001), and other CISCO academy programs such as that established with Tangaroa college in Auckland (Collins, 2001).

6. CURRICULUM DELIVERY MODELS

A loose collection of vendor certifications, unit standards and a small subset of the technology curriculum represent the current state of computing education in many New Zealand high schools. This lack of coherency is unnecessary and undesirable. In countries such as Israel and the United States specific computer science curriculum models have been proposed, with recommendations that computer science be taught as a separate subject (Gal-Ezer & Harel, 1999, Tucker *et al.*, 2003). However, in practice it appears that the experiences in the US have been no more successful than our own. The proposal for an IT Fluency model in this paper extends beyond computer science as a discipline. It should be capable of supporting more interdisciplinary delivery models in which the FITness elements may be developed in a portfolio of courses to suit the local circumstance of each high school. For instance those with existing CISCO academy linkages may include those elements in their overall programme in a standards based assessment approach (Barker, 1995), that can be utilised towards achieving FITNess. NACCQ modules at levels 3, 4 and (if desired, level 5) may then serve to augment such curricular elements. For the more generic graduate profile, many of the elements may already be taught in core academic disciplines (such as biology, English, mathematics, physics) and IT may be used as an integrative device in supporting both the core curriculum delivery and FITNess development. In this way a "threaded curriculum" model (cf. Fogarty, 1991, Clear, 1997) may be a means of achieving the outcomes. This would occur by applying some careful course redesign without the need to completely disrupt existing courses or imposing extra workloads on already stretched high school teachers. NACCQ with its long history of national computing curriculum developments; relative independence; and its industry and high school linkages, is well positioned to advise on suitable national curriculum models and components.

7. CONCLUSION

This paper has positioned the FITNZ initiative, proposed a set of graduate profiles at the senior secondary school level and identified a role for NACCQ in the context of a significant educational partnership between industry, secondary, government and tertiary sectors. It has proposed a flexible model for high school computing curricula which avoids radically disrupting existing arrangements, while achieving a consistent and measurable level of student capability in IT. The paper is intended to briefly profile developments so far for critique by interested parties.

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