Full paper

Best Practices for IT Education: Vocational and Continuous Learning

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ABSTRACT

Internationally, tertiary institutions are examining the issue of declining student enrolments and a reduction in student retention. The British Computer Society's recent report is typical of this debate. Many discussions focus on making the existing programmes more appealing or establishing pre-entry courses that will better prepare students for the main programme. We propose an alternative strategy which adopts a trade and vocational model for IT education complement the existing academic programmes. This model attempts to embrace both the entry level technician and the experienced IT practitioner who is seeking continuing education and professional development. Further research is needed to confirm the exact nature of the courses that are being sought by those seeking vocational education in the IT field.

1. INTRODUCTION

A number of publications and conferences have focused on the declining number of students enrolling in traditional computing courses (McGettrick, Ibbett, Loydd, Lovegrove & Mander, 2004; Mann 2005; Roddick & Nieuwenhuis, 2001; de Raadt, Watson & Toleman, 2004). Of those students that enrol, the completion rate is falling as an increasing number of students drop out of courses before graduation (McGettrick *et al.* 2004). A number of reasons have been suggested for this trend including:

• The size of the field of computing confusing the potential student (McGettrick *et al.* 2004).

• The complexity of the field as an area of study (McGettrick *et al.* 2004).

• The perception by students that computing courses are dominated by programming (McGettrick *et al.* 2004).

• The ease of employment during buoyant economic times which discourages career changing for the older student and encourages the deferment of higher education in the school leaver (Mann 2005).

A general question that arises from the discussion is "What are we to do"?

This paper discusses a recent report issued by the British Computer Society (BCS) which raises several important questions. A number of observations are made of the place of education within the computing industry and we suggest some possible directions that may be complimentary to the solutions coming from the BCS.

2. ONE ATTEMPT AT THE GRAND CHALLENGE

The British Computer Society held a series of conferences in late 2004 in which the challenges of computer education were discussed. The discussion and conclusions are published in a report titled "Grand Challenges in Computing: Education". Tony Hoare was quoted in the report as stating in a private communication

> *"The fundamental question in any branch of engineering is 'how does it work?' The fundamental question in any branch of engineering science is 'why does it work?' These are exactly the fundamental questions of software engineering and computer science. We must therefore inspire our students with curiosity about these questions, and then satisfy it. In most branches of engineering, this requires some mathematics, and the students often object. We just have to live with that.*
>
> *Of course, there will always be students who have little curiosity, and only want to learn 'how to do it' so that they can earn lots of money. They are the taxi drivers of the world, not the automobile engineers. We need them,*

and they need vocational courses in how to set up and maintain computer networks, databases, websites etc. Perhaps they don't even need to know how these systems work, but in a university they should be taught all the same, because one day it might help." (McGettrick et al., 2004 p7)

This communication sets the tone for the remainder of the Grand Challenges report. McGettrick *et al.* identify a number of problems, issues and challenges faced by those of us in the field of computing education. These problems are summarised above. However I feel that they miss an opportunity with their conclusion that the only solution to the challenges is to continue to offer the same, but perhaps refined, type of education.

Tony Hoare, in particular, fails to realise that between the automotive design engineer and the taxi driver there are a wide range of highly skilled people who support the automotive field. To extend his analogy, we need to add the mechanics and trades people in the industry – and we need to recognise that they possess a very respectable level of skill and knowledge.

Hoare's engineering questions are worth considering further and reflecting on the applicability to Computing Education. In addition to the Pure Engineering's "How does it work" and Engineering Science's "Why does it work" we might add an Applied Engineer (or trades person) "What are the Best Practices to make it work?".

3. TRADES ARE IMPORTANT

It is understandable that an academic in a University might not be concerned with the training and professional development of those who have taken a non-academic career pathway. But as academics working within institutions that have a wider brief than simply that of scientific and academic development, it is important that we consider the training and professional development of those who support our infrastructure. It is irresponsible and foolhardy to only concern ourselves with the design and scientific end of our field.

In New Zealand we have been made acutely aware of the importance of recognising and fostering trades. We shouldn't be surprised that buildings leak when they are constructed by untrained people. We are no longer surprised that after neglecting to recruit and train apprentices we find that there are few trades -people to call on. If you are lucky enough to find one who actually answers a telephone, it is harder to make a firm appointment than with a doctor, lawyer or engineer. If we had an abundance of civil engineers I still couldn't get my roof fixed!

The field of IT is very young compared to other disciplines such as manufacturing, the construction trades, finance or accounting. In fact the body of knowledge developed for managing IT and IT departments' does not cover a period of more than three decades (Igbaria & Shayo, 2004).

In spite of its youth, IT is developing into a mature component of business infrastructure. Carr (2003) makes an important point when he suggests that today "it is unusual for a company to gain a competitive advantage through the distinctive use of a mature infrastructural technology. But even a brief disruption in the availability of the technology can be devastating" (Carr 2003). In many ways the IT systems used within businesses today are hygiene factors. The information technology will not make a business stand out – but if systems are lacking or faulty then the business will be vulnerable.

The reliable configuration and maintenance of IT is not contained within the technology itself. While some strive for self healing networks and operating systems (Poor, Bowman, Burgess-Auburn 2003, Shapiro, 2004), the actual implementation and maintenance work is undertaken by skilled people. We are seeing the rise of a trade within the computing field. A group who are not engaged in protocol design or analysis – but can identify problems within the implementation of a network and problem solve complex networking issues; who do not program LDAP applications but can actually make eDirectory and Active Directory play nicely. We are seeing the evolution of a sub-field within computing, one that keeps the infrastructure working.

4. IT SUPPORT

Small and medium enterprises require support for their infrastructure. The IT Infrastructure is more than hardware, off-the-shelf software and broadband pipes. IT has a critical role providing

the infrastructure for the productivity and operation of industry. The most important resource in providing this infrastructure is the people (Poulson Higgs Co. Ltd, Nind, Alexander and Benwell 2002).

It is crucial that we consider the training needs for supporting the infrastructure. This leads to questions such as whether the approach of the Capstone Project in an IT degree should be developmental (the direction taken by the B.InfoTech at Otago Polytechnic) or cooperative (such as that used at CPIT). It is possible that we should allow for diversity within such projects so that all areas of computing are able to be addressed.

It is common to break the IT support industry into a taxonomy of three levels:

Level 1 support is primarily helpdesk who receive notification of jobs and handle telephone enquiries

Level 2 support involves "break-fix" technicians with a greater level of skill who may solve the problem remotely or be sent to the client area

Level 3 support is usually the server and systems administration staff or specific teams within an IT department (Carswell, 2005).

The training needs of level 1 and 2 technicians has been largely overlooked in the field of computing education. Such staff have fallen between cracks in the computing industry. They are often alienated from the academic emphasis within most tertiary programmes, but there are no apprenticeship programmes available as there are in other fields. Indeed there is no trades body or Industry Training Organisation (ITO) in this field in New Zealand.

We have encountered many tales of misaligned training: a junior technician wanting formal education in IT wasted time enrolling in a business oriented course which was not appropriate for the field in which they were currently working; employers seeking qualified staff having to pay more than they intended to for degree graduates, who soon became bored and moved on; and so on.

The training needs of the support technician are likely to be twofold; both initial training and needs for ongoing professional development. The initial education of the more advanced IT professionals is catered for by numerous successful degrees. These graduates find roles in professional positions such as systems analysts, network design, IT management etc. A great many of them become the sole charge IT specialist in small and medium size businesses.

There are, however, few opportunities for on-going professional development for these graduates. Academic post-graduate study is often not wanted and many are equally reluctant to take on industry certification. The most common reasons given to the authors for avoiding professional certification is the cost and the delivery methods. While many express a desire to undertake certification programmes as part of on-going professional development the choice is usually between self-paced study (books or e-learning) or attending crash courses where a semester's worth of work is delivered in a few days. Few enjoy this experience, fewer still remember what it was they learnt when they get back to work the following week. The course becomes 'folderware' which sits on the shelf and is never implemented, or even referred to. Anecdotally, the most commonly reported positive element seems to be the social networking that occurred within the courses.

There is a need to provide on-going professional development support for our graduates. It is a fallacy to suppose that once someone has graduated with a degree, or higher qualification, that they would not benefit from further development at a supposedly "lower" level. Otago Polytechnic regularly has students with Bachelors degrees, Masters degrees and even the odd PhD attend the Cisco Network Academy Programme which we run at night. One's professional development needs are not simply a succession of ever more complex topics. This is confirmed by recent Australian study which showed a strong trend for university graduates to take vocational courses for further development (Harris, Sumner & Rainy, 2005).

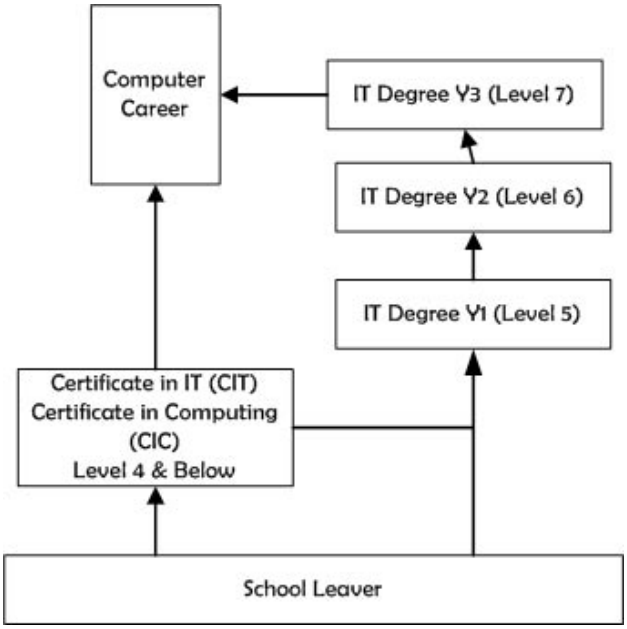

Figure 1. Current View of the Entry Paths for an IT Career

5. MODELS OF COMPUTER EDUCATION

5.1 Contemporary Computer Education

The courses that are currently offered by the general computer education sector appear to take a view that the career entry structure for IT staff resembles Figure 1. This is a simplified diagram which ignores the exit points that some institutions offer at the end the NZQA level 5 and 6. A more detailed poster of this view of career entry development exits (NACCQ 2003). This diagram is firmly focused on the entry point being the school leaver and a definite exit point of the job market.

5.2 Multiple Paths to a Computing Job

There is a tendency to act as though all people enter the IT field via the programmes offered within our institutions. But, there are other pathways to employment in computing. We know of many people who have begun programmes and then left before graduation and now work in computing. It is unfair to say that they have "dropped out" and to then wipe our hands of them. These people have not withdrawn from the industry. What they have done is to withdraw, for various reasons, from our approach to computing education. We are not necessarily implying that we have failed these students. Their contact with us may have provided the impetus to progress along their chosen path.

We have also met numerous people working within computing who began their career without any formal computer education. These people either rejected our approach to pre-career education, did not find our offerings relevant, or were unaware of our offerings. Failing to recognise the entire range of entry paths into computing is to remain ignorant of the reality of certain aspects our field. And it is a failing to recognise numerous opportunities for becoming further involved in the field of IT education

By factoring in the numerous entry points into a computing career, a model is developed such as that in Figure 2. This model acknowledges that some people take paths that involve education outside of the tertiary area, while others drift into computer careers. An example of this drift would be an accountant who looks after a payroll system and then finds that she's now the systems administrator and hasn't done any actual accounting practice for years.

This model is a little cluttered and may not include all possibilities. The aim is to show that there are more entry paths into a computing career than the simplistic assumption of school -> computing degree -> career. People drift into computing; arrive via self study or private training and certification, all manner of means. Perhaps we should be starting to ask whether we, as IT educators, should be involved in these "other" entrant paths – and if so, then how?

5.3 Life Long Learning

While our existing approach to teaching is extended with the second diagram, it is still focused on the entry to computing careers. This approach then loses all concern for the student.

Another computer education issue is that of life-long-learning or professional development. We claim to support and value lifelong learning (Laxer 2000) but have a model which terminates with the job market. A little lip-service is paid to this area by allowing those in the workforce to come back and pick up papers offered within existing programmes, or to continue with the

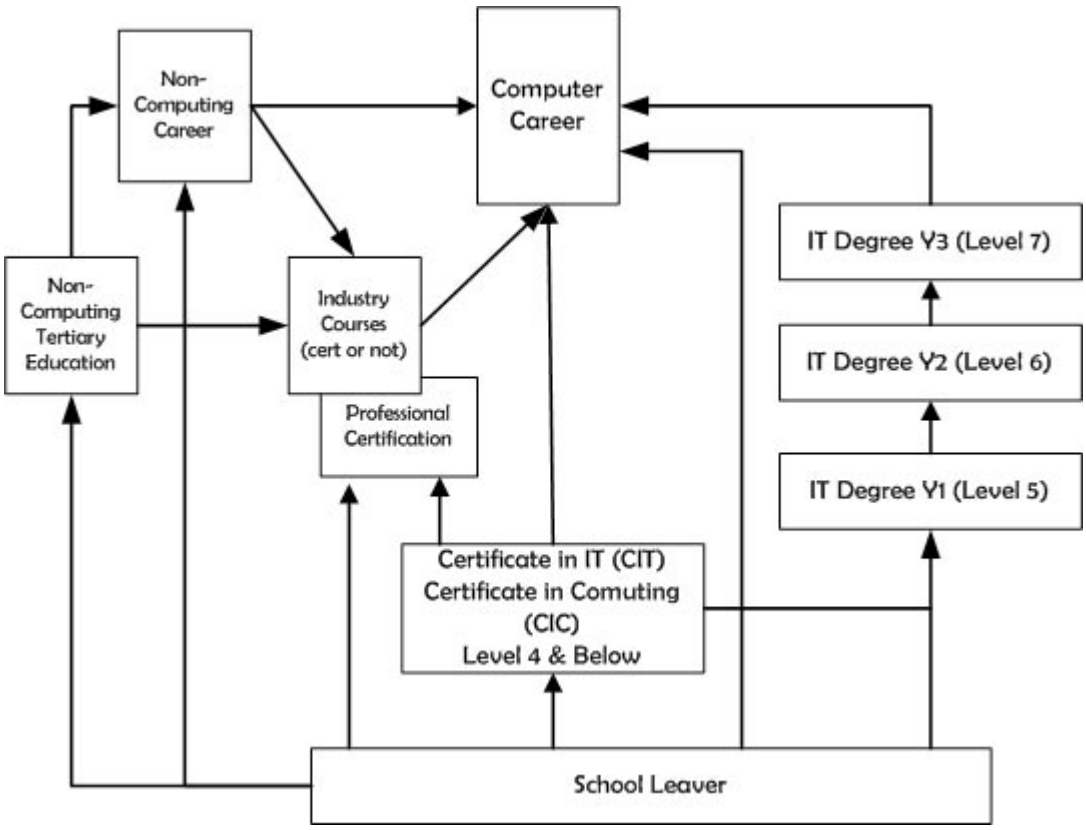

Figure 2. Actual Entry Paths to a Computing Career

academic path towards Masters and PhD. For many this is a valid and valuable pathway for further learning.

There is no doubt that anyone in the industry will engage in further learning; formal or otherwise. It is a matter of necessity, of survival in the workplace – it is a fact of life. When considering the actual computer education universe, rather than just the entry to computing as a career we must bring in continuing education, in its many and varied forms.

This is pictured as Figure 3. In this diagram a wide arrow is indicating that the education forms part of the entry point to a computing career and a narrow arrow indicates the participation of a person already employed in a computing job.

When viewed in this manner we begin to observe that most forms of computing education may play a dual role of pre-entry and on-going professional development.

5.3.1 The Polytechnic Sector within Continual Education

If we really wish to take a part within the on-going education of people within the computing industry then we need to consider courses that are wider than those designed to prepare students for entry to the industry. We should try and place ourselves within each and every one of those arrows; thick or thin; entry or ongoing development. This may require a dramatic change from the delivery methods and course offerings with which we are familiar.

6. POSSIBLE DIRECTIONS

We suggest that there is a need for programmes specifically designed to both develop the would-be computer technician and to provide on-going professional development support for the computing practitioner. We need to develop courses designed both for the entrant and the expert. These courses serve as both parallel and complimentary paths to those taken by people choosing an academically oriented degree pro-

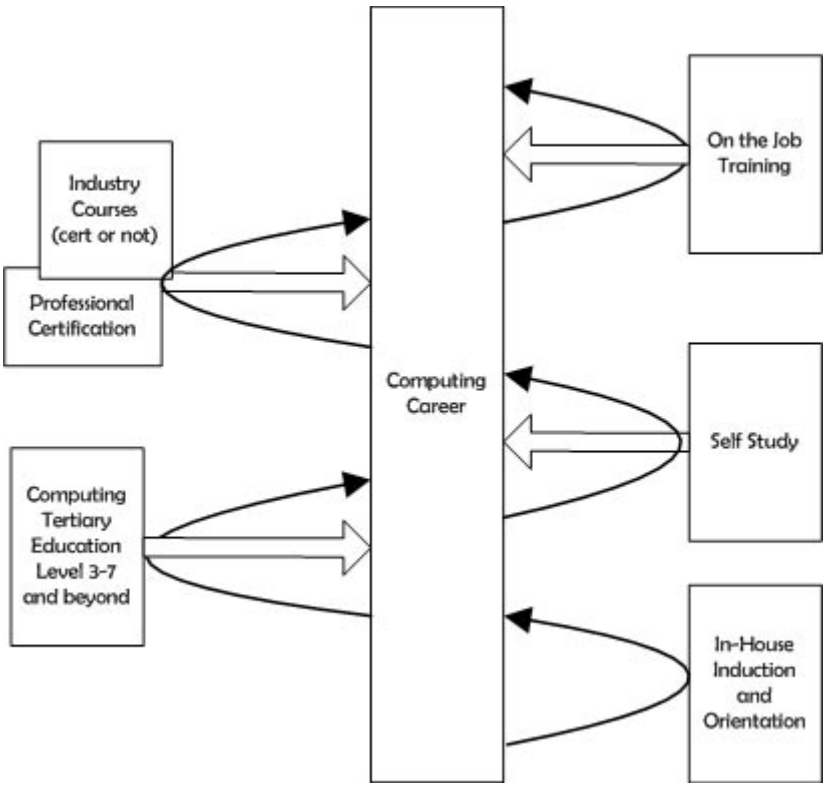

Figure 3. Computing education as ongoing process

gramme.

A number of institutions have developed "Computer Technician" programmes and are awarding tertiary certificates or diplomas on completion. Those at CPIT, CIT, Massey, and elsewhere, are well established. Otago Polytechnic is moving also in this direction. The approach is wholly vocational in nature. These courses are not intended as a pre-entry to a degree programme, although some students may find that they wish to continue in that direction. The emphasis is on "best practice" rather than innovation and design or on science and academia. Having said that, a well rounded and capable IT support professional should be able to adapt the best practice to their environment in new and innovative ways.

6.1 The Place of Professional Certificates

One of the issues that we have faced in our local attempt to address the technician education gap involves consideration of the existing professional certificates. We have followed several institutions in adopting a number of these professional programmes. This is not because we believe that IT certification programmes are necessarily good per se. On the contrary, some are absolute rubbish. But there are a number of very well researched and developed programmes that contain a considered and thought out curriculum. In many cases the resources that have gone into developing the certificates are far greater than we could supply to develop something locally. If a curriculum is available for use, and if it is of an acceptable quality, then there is little point in re-inventing the wheel by developing yet another variation.

It is important that the certification programmes receive careful consideration before being adopted as a component in a larger programme. It is easy to fall into one of two extremes. At one end we assume that a certificate is valuable simply because it is popular or developed by a major player (such as Microsoft). Discounting anything developed outside of academia is equally bad (for example assuming that Microsoft courses are by definition content-less vendor supplied propoganda).

We have also found it necessary to focus on the actual curriculum of the professional certificate rather than a particular text book or delivery

product. At one stage we found ourselves debating the merits of the CompTIA A+ certificate based on our opinion of the approach taken by Cisco. We were evaluating the curriculum based on a third party text, we were not evaluating the actual A+ curriculum at all. This was a mistake. After identifying this distraction we returned to consider the actual CompTIA objectives, deciding to postpone the selection of teaching material to a later stage.

There has been much debate surrounding whether tertiary institutions should become involved with private certification programmes, many of which are associated with a particular vendor (Yuan, Moffitt, Bailey, Nix, & Terrell, 2002; Mason, 2003; Schichting & Mason, 2005; Schichting & Mason, 2004; Mulkey, 2003; Adelman, 2000; Cegielski, 2004). This debate is primarily directed at academic degree oriented courses. We believe that the debate is of interest to vocational courses but should not necessarily direct their development. The aims, needs and character of a vocational programme are not necessarily the same as an academic one.

It is expected that people already employed within the IT industry may make use of these courses as part of their own on-going professional development. We have already seen graduates return at night to attend the Cisco CCNA programme that we offer. It is our hope that people who are already working in the IT field will enrol in our technician's course as part of their ongoing professional development. Some of these people may have not have had a previous relationship with us, others may be graduates from our programmes. In addition to enrolling the new entrants to computing we are aiming to recycle our graduates and to form new relationships with computing professionals that we have never met.

6.2 The Need for Research

Our attempt at programme development in this area is based on anecdotal observation that some students were not succeeding because of both the level and content of our other programmes. Some students were dropping out and reporting that it was because we were not offering what they were looking for. Our general retention is not bad – but a gap was identified. This gap is confirmed by reports such McGettrick *et al.* (2004)

Employers also identified the need for a particular type of graduate that we were not providing. After three years a degree graduate has an ambition to go beyond level 1 and 2 support. In some businesses there is a career structure within the end-user support field that includes roles such as team-leader. But not all businesses are large enough for such a position. One manager commented that he wanted "highly skilled ambitionless graduates that would stay put".

We have no wish to train ambitionless automatons, and that was not really what that manager was after. But his point is well taken.

It would be very beneficial to find out, through a more rigorous research process, what it is that employers actually want from their employees. It would also be useful to find out what further training and professional development is attractive to those working within the field. There is a need to undertake formal research within this area. Finding the answer to these questions would allow us to target courses so that they are more useful to our existing students. It would also allow us to identify areas in which we can support our graduates with further life-long learning. We would like to recycle our graduates.

6.3 New Data May Indicate New Approaches

It is very possible that the research conclusions indicate that there is a demand for something we cannot provide. That's fine, and quite interesting to identify. It is also quite likely that the results indicate that there are things that we can provide but that our existing methods of provision are inappropriate.

We need to prepare ourselves for considering learning environments such as mentoring, on-the-job training, co-operative learning, block modules, night classes and negotiated contract learning, among others. Flexible delivery may not be an interesting option: it may be a requirement.

7. CONCLUSION: NEW ANSWERS TO GRAND CHALLENGES AND NEW PRACTICES TO DEVELOP

The British Computer Society's report on their Grand Challenges conference identified a number of very important issues. Students are failing to enrol in computing courses for various reasons. Their response appears to be that the solution is to carry on offering the same type of material – but maybe prepare students for it earlier, in high school – and that the students will just have to learn to live with it. Perhaps the confines of the University structure prevent any other alternative. However for those of us teaching in other institutional environments we should not feel as restricted.

If students are failing to enrol then we need to find out why. What is it they want? What is it the employer needs? And, having identified the issues, we should develop solutions that are suitable to both the student and employer. Sometimes this might fit nicely within existing programmes, sometimes new programmes may be suggested and sometimes we may find that a completely different approach is indicated (IT apprenticeships perhaps, or workplace mentoring). Whatever the solution, it should be done in conjunction with real data and community consultation. Pretending that vocational and trade related areas don't exist within computing is not an option.

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