E-Learning at Work and the Workplace
From Education to Employment and Meaningful Work with ICTs
Proceedings of the European Distance and E-Learning Network 2014 Annual Conference
Zagreb, 10-13 June, 2014
ISBN 978-963-89559-7-5
ISSN: 2707-2819
doi: https://doi.org/10.38069/edenconf-2014-ac-0051

VOCATIONAL EDUCATION AND THE EVOLUTION OF THE COMPUTING DISCIPLINES

Martin Atchison, Joze Kuzic, Monash University, Australia

Introduction and Context for the Study

Throughout the relatively brief history of IT, undergraduate teaching programs in the IT disciplines have had to cope with the traditional antipathy of universities towards vocationally-based education. This resistance towards vocationally-oriented education has been a common feature of universities since their origins as educational institutions. The earliest universities followed the example of the ancient Greek academies, in favouring disciplines which focused on pure knowledge, independent of its application in practice (Ruegg, 2004). Consequently, throughout most of the history of the university, studies in the fields of engineering and technology were excluded on the grounds that they were too 'utilitarian', lacking in the theoretical foundations deemed appropriate to a university academic discipline (Guagnini, 2004). It was not until the late 19th and early 20th century that the disciplines associated with technology and the applied sciences began to earn widespread acceptance as suitable fields of study for universities (Ruegg, 2004).

Five IT specialist disciplines have been recognised and defined by the American Association of Computing Machinery (ACM): Computer Science (CS), Computer Engineering (CE), Information Systems (IS), Software Engineering (SE) and Information Technology (IT). Many of the accounts of the formation of these IT-based disciplines show initial reluctance by many institutions to accept their academic legitimacy as technology-based fields of study (see e.g., Aspray, 2000; Baron & Mounier-Kuhn, 1990). This paper summarises the key findings of a study whose aim is to examine the way in which these disciplines have been treated within the higher education system of an entire region – the State of Victoria in Australia. The study takes a historical approach, examining the way in which IT education has evolved within the undergraduate teaching programs of Victoria's higher education institutions. It describes how the academic/vocational divide has affected the evolution of IT education, and evaluates the level of success achieved by IT disciplines in earning recognition in undergraduate teaching programs.

Context for the Study – Higher Education in Victoria

Victoria is one of seven states (and two territories) which comprise the federation of Australia. Although it is the smallest of the mainland states it is the most densely populated, and its

performance against most of the key economic indicators puts it in first or second place when ranked against the other states. Its population of about 5.7 million is highly centralised and urbanised, with about 4.2 million living in the state capital city, Melbourne.

In order to understand Victoria's higher education system, it is first necessary to understand the basic structure of the Australian higher education system and the way it has changed during the period covered by the study. Historically, most higher education institutions in Australia have been government-owned and controlled, with State governments having responsibility for establishing and running the institutions, and the federal government directing educational policy and providing the bulk of the funding. In Victoria, the University of Melbourne (established in 1853) remained the State's sole university until the late 1950s, supported by a range of technical colleges and other specialist educational institutions offering vocationally-oriented education and training in a variety of fields of study. A similar pattern of development of the higher education sector was followed in the other Australian States.

Community demand for higher education began to increase rapidly during the 1950s, causing the federal government to expand and restructure the sector. A central feature of this restructure was the creation in the early 1960s of the so-called 'binary system', which aimed to formalise a two–tier structure for higher education institutions. One tier comprised the universities which were expected to be research-oriented, and to offer bachelors degree programs which were more theoretical and focus on higher-order general cognitive skills. All other institutions were grouped into the second tier under the general title of Colleges of Advanced Education (CAEs); they were to be vocationally-focussed, do minimal research, and mainly offer diplomas as their highest level of qualification, with an emphasis on instruction in the knowledge and skills required for particular workplace tasks.

The establishment of the binary system led to a major re-structuring of the higher education sector. For the first tier, the main change was the introduction of new universities; in Victoria, three such universities – Monash, Latrobe and Deakin were established to supplement the University of Melbourne. The picture was much more complex for the second tier, which comprised a much larger and more diverse set of institutions. In Victoria the number of CAEs peaked at more than 35 institutions focusing on a variety of professions and vocational outcomes. By the late 1980s, when amalgamations had significantly reduced the number of CAEs, the State still had about 20 such institutions. Most CAEs underwent significant changes as they adapted to their new roles in the binary system. In particular they sought to dispel perceptions of themselves as the 'second-class' of higher education institutions and to be treated as equals to the universities. As part of this ambition, they gained approval via the State governments to over-ride the binary system's proposed restriction on the qualifications they could offer, and included bachelors degrees and even masters degrees in their programs.

In the late 1980s the binary system was abolished, and replaced with a new unified national system for tertiary education. The distinction between universities and CAEs was eliminated, and funding arrangements were changed to encourage higher student enrolments, increase the sector's responsiveness to marketplace pressures and bring about organizational mergers

ISBN 978-963-89559-7-5

to create economies of scale. The outcome of these reforms was a complete re-organization of the higher education sector, with CAEs amalgamating with existing universities or merging with one another as new universities. In Victoria this process of re-structuring and amalgamation took place very quickly, beginning in about 1990 and being largely completed by the mid-1990s. It resulted in the reduction of the number of institutions to eight universities, catering for a rapidly increasing student population. The reforms broke the divide between vocational and 'academic' institutions and increased the exposure of universities to market forces. Universities were increasingly treated as mass-market education providers, which were expected to move towards financial self-sufficiency and eliminate their dependency on government funding. Although there has been much controversy about the impact of these changes on higher education, the basic structure which they established for the sector has remained unchanged to the present day.

The remainder of this paper examines the way in which IT education evolved against the backdrop of the changing higher education system. Note that the number and diversity of the institutions involved mean that it is impossible in a paper of this length to do more than describe broad general patterns of the evolution of IT, and omit the many cases where some programs within individual institutions differed in some way from the norm. A fuller description of events, including consideration of these differences can be found in Atchison (2013).

The Evolution of IT Programs in Victorian Higher Educational Institutions

Period 1: Emergence and establishment – 1960-1990

In Victoria, computing education first emerged in about 1960, and the pattern of its development ran broadly in line with the binary system's division of responsibilities between the two higher education sectors. The four universities generally confined themselves to programmes in the then best-established IT disciplines of CS and CE, and maintained their resistance towards vocationally-oriented programs throughout most of the period. Only Deakin University maintained a significant emphasis on vocational programs in computing, and these came as a consequence of that institution's origins as the product of a merger of CAEs; its two applied computing programs had been established in its constituent CAEs prior to the institutional merger in which Deakin was formed.

By contrast, in CAEs the main emphasis was on vocationally-focussed computing programs, explicitly aimed at preparing graduates suitable for workforce needs for computing professionals with skills in developing and implementing computing applications. By the end of the period, twelve CAEs were offering at least one IT-based program of this kind. These programs were usually located in either a business or science faculty, but regardless of differences in the names of programs and their location within the institutional structure, their program objectives were described in similar application and practice-oriented terms. Their curricula covered a similar range of topics, including programming, systems analysis and design, computer hardware, operating systems, database, computer applications and data

ISBN 978-963-89559-7-5

communications and networking, but with individual variations in emphasis according to the program's origins and orientation. Despite the perceived lower status of CAEs and the failure of these IT programs to conform to the disciplinary models recognised at that time by the ACM, they were widely regarded by industry as providing the best IT graduates. A federal government enquiry into IT education in 1976 found that many employers were unhappy with the nature of the education provided by the more academically-oriented university programs, and preferred to employ CAE program graduates, who had a better grounding in the practical aspects of organizational computer use (De Ferranti & Smith, 1976).

The process of formation of most of the applied computing programs can best be explained in terms of what Metzger's (1987) model of disciplinary formation described as subject parturition. Initially a set of computing units was established to support the application of computing as part of a specialist program in another discipline; over time, the number of computing units grew to the point where they took on an independent existence as a separate program of study. The parturition process did not always mean an immediate complete separation between the 'parent' discipline and its computing 'offspring'. The two disciplines often continued to co-exist, perhaps as separate but related majors within a common degree program – for example a stream of computing units in an accounting major might evolve to become a specialist major in business computing alongside the 'parent' accounting major within a business degree. The process of evolution from supporting units to the status of an independent specialist program was normally spread over a period of several years, but the speed with which it occurred depended on a range of factors which were specific to each institution.

Within business faculties, accounting was the discipline which was most commonly associated with the initial introduction of units in computing, and therefore it was the most common disciplinary 'parent' of specialist business-based computing programs. But computing units were also common in many business programs which emphasised quantitative and mathematically-oriented approaches to the study of economics, or which dealt with the use of systems for business processing, and they too became the starting point for computing programs in several CAEs. In the later years of the period, advances in the use of computers for word processing and general office work led to some computing programs evolving from business programs which focused on administrative or secretarial studies and information management. In science faculties, the disciplinary roots were not so variable; applied mathematics, quantitative methods and operations research were almost universally linked as the initial source from which science-based computing programs evolved.

The difference between the disciplinary roots from which applied computing programs formed meant that it was commonplace for separate programs to be established in different faculties within the same institution. In fact, by the late 1980s, most of the CAEs which taught computing offered two applied computing programs – one based in a business-oriented faculty and the other in a science-oriented faculty. Despite the surface level similarities in the curricula of these programs, the differences in the underlying applications on which the programs focused enabled the institutions to justify maintaining them both.

ISBN 978-963-89559-7-5

Applied computing programs went by a variety of names. In business faculties, they were initially widely labelled as 'EDP' or 'data processing' programs, but over time this term was replaced by 'business computing' as the most common name; 'Information Systems' or 'Business Information Systems' were relatively uncommon, but began to become more popular towards the end of the period. In science faculties all programs were labelled with the names 'computing' or Computer Science', with roughly equal numbers of each. Despite the shared name, the CS programs at CAEs were clearly distinguishable from their counterparts in universities; they had the same vocational objectives as other applied computing programs, whereas the university CS programs were more theory-based, narrower in their scope, and focused on the nature of CS as an academic discipline.

Period 2: Re-organization and Consolidation – 1990-1996

The round of institutional mergers and re-structures which accompanied the elimination of the binary system played a major role in re-shaping the IT educational environment. Most of the mergers brought together two or more institutions which offered multiple IT programs of different types, which meant that each new university had to take decisions about how they should be accommodated within the re-structured institution. In most cases these decisions served to consolidate and strengthen the place of IT disciplines within the academic hierarchy.

The first important aspect of this process of consolidation was the formation of specialist IT-based departments. Although specialist IT-based departments had been common in the universities before the mergers/re-structures, most of the IT programs in the CAEs had remained alongside the discipline from which they had initially evolved. The institutional changes provided the opportunity for IT to separate itself and its programs from these disciplinary partners. By the end of 1996, the vast majority of IT programs in all universities were offered by organizational academic units which specialized in IT, independent of other disciplines, which gave IT a much stronger disciplinary presence in each university. There were, however, only limited signs of any form of disciplinary convergence between the separate IT disciplinary specialisations. In most universities, the new IT-based departments remained in the faculty from which they had originated, which meant that the IT programs remained scattered across 2-3 different faculties, usually those of science, business and engineering. The most notable exception was at Monash University, where that institution's re-structure was used to bring all aspects of computer-related education together into what was claimed to be Australia's first specialist IT faculty, consisting solely of IT-related academic departments.

A second key effect of the re-structures was to broaden the range of areas of IT which each university covered in its academic programs. Whereas institutions in the previous period usually offered only 2-3 different IT-based programs, by 1996 there was an average of about 5-6 specialist IT programs per university, covering a broader range of IT disciplines. In most cases, each merged university retained (sometimes in modified form) all the IT programs which had previously existed in the institutions which were involved in the merger; in only a few cases did the institutional mergers lead to two programs from the different institutions

ISBN 978-963-89559-7-5

being combined into one. Hence, despite the decline in the number of institutions, the overall number of IT programs offered across the higher education sector remained much the same.

The most noticeable change in the range of IT disciplines offered by the re-structured universities was the rise to prominence of the discipline of Information Systems. By the end of 1996 almost every university offered a program of that name (or a comparable name, such as Business Information Systems or Business Systems). However, this increase in IS programs was due chiefly to changes in nomenclature, rather than to the establishment of new programs; only at the University of Melbourne was a new IS undergraduate program (and the department which offered it) created from scratch during the period. In all other universities, the new IS programs were formed as re-named versions of applied computing programs which had carried over from the previous period.

This meant that IS joined CS and CE as the best represented of the IT specialisations, with almost every university offering at least one specialist program in each discipline. Most universities also continued to offer at least one other generalist applied IT program of the type offered by CAEs in the previous period; these were commonly labelled as Bachelor of Computing or Bachelor of IT. The first specialist Software Engineering programs also appeared at three universities in this period, closely associated in each case with the university's CS program. A handful of other specialist programs also developed alongside the 'mainstream' IT disciplines during the period; they covered emerging areas such as multimedia, network engineering and systems support, and were the vanguard of a much larger group based around specialist areas of computer technology and its applications, which appeared in the next period.

Period 3: Growth and Expansion – 1996-2003

The dominant influence on the development of IT education during this period was the rise in public interest in computing which accompanied the so-called dotcom boom of the late 1990s. As a consequence of the technological developments in areas like multimedia and the world-wide web, and the continuing increase in the accessibility of computers, the period saw a surge in interest in IT education which was reflected in rapid increases in student demand for IT-related programs. As well as attracting greater interest from domestic Australian students, IT was also a popular choice among international students, whose numbers in Australian universities increased dramatically throughout the period. For IT departments, the rapid rate of technological change combined with increasing student demand to create pressure for new academic programs.

These pressures for new programs were also exacerbated by the impact of broader trends in the higher education sector. Federal government policies continued to favour the development of universities as mass education providers, leading to strong increases in enrolments of domestic students in Australian universities and even higher increases in the number of international students. This created a larger and more diverse student population with expectations that university programs would accommodate their various vocational

ISBN 978-963-89559-7-5

educational needs. Consequently the design of IT programs began to be affected as much by what was perceived to be likely to be popular with the student market as by the dictates of disciplinary standards.

The net effect of these pressures was that by 2003, shortly after student demand had reached its peak, the number of IT programs offered in Victorian universities was almost double the number which had been offered in 1996. The new programs were spread across a wide variety of areas of IT and IT applications; some were off-shoots of the mainstream IT disciplines focusing on advances in traditional technologies, but most were based on emerging specialist areas of technology, such as web design, e-commerce, games development, security and mobile computing. The introduction of these new programs was driven by a mixture of motivations. From a purely academic point of view, they aimed to build and disseminate a base of knowledge around newly emerging technologies such as multimedia and the web and their application in areas such e-commerce, media, computer games and the like. Secondly, they aimed to meet a vocational objective of satisfying perceived market need for new types of IT specialists such as web designers, information architects, games developers and the like. Finally, they aimed to take advantage of the opportunity presented by the increased levels of public interest in IT, and attract students who would not be interested in the traditional IT disciplines.

Although all universities increased both the number and the variety of IT programs they offered during this period, the number of new programs and the themes on which they focussed varied between universities. Each IT-based department shaped its strategy to suit its own circumstances, and the outcome in terms of program offerings varied accordingly. By the end of the period, all universities offered programs in the four mainstream IT disciplines – CS, CE, IS and SE, and almost all of them offered some form of generalist IT program of the kind which the CAEs had originally offered. Beyond that, each institution had its own unique blend of specialist programs in particular aspects of computing technology and different areas of computer applications.

Period 4: Decline – 2003 - present

This period was dominated by the effects of a decline in student demand for IT education which was longer and more pronounced than the period of growth which preceded it. Between the peak of student demand at the height of the dotcom boom and the point when its decline ended in about 2008, the demand for IT programs across all universities fell to about one-third of its peak levels and about half the level which existed in 1997, prior to the beginning of the boom. During the remainder of the period demand plateau-ed, with only minor fluctuations up or down from one year to the next. Although it is only indirectly relevant to universities, it is worth noting that a similar trend occurred in secondary schools, where the number of enrolments in the optional IT units in the final year of secondary education fell from their peak in 2001 to a level which was less than half of what the units attracted when they were first offered in 1992. It is also worth noting that similar problems of

ISBN 978-963-89559-7-5

declines in student numbers and quality were observed at universities throughout much of the developed world during this time (see e.g. Benokraitos et al. (2009); Granger et al. (2007)).

The collapse in student demand made this period the most turbulent in the history of IT education in Victoria. Declining government funding levels made economic viability an increasingly important consideration in internal university assessments of their academic departments and programs, which meant that the likelihood of a program's survival was determined more by its market appeal to students, than by its claims to disciplinary legitimacy or its perceived fit with industry needs. Where IT had flourished in the previous period as a consequence of its increasing student demand, the decline in demand now exposed IT departments and their programs to severe critical scrutiny. Their response took two contradictory forms – on the one hand, many programs whose student numbers had declined were closed down, but on the other hand, new programs were established in the hope that they could re-capture the lost market. For the first couple of years of the period, the number of new programs actually matched the number of losses, so that the overall number of IT programs offered remained roughly the same. It took until 2005 for the severity of the slump to become clear, at which point the rate of closures began to excess the rate of commencements, and program numbers began to decline. By the end of the period, the overall number of IT programs offered in universities had returned to similar levels to those which existed in 1996, before the dotcom boom began.

Most of the program losses (and the short-lived additions) were in specialist areas of IT applications; in particular areas such as e-commerce and multimedia, which had prospered during the dotcom boom, declined significantly. Program losses also extended into the mainstream IT disciplines, which meant that by the end of the period almost all the universities had ceased to offer at least one of the ACM's set of core disciplinary programs. The most successful area in terms of new programs was in games development – an area of IT which has no disciplinary recognition from the ACM, offers relatively few employment opportunities in a niche industry segment, but has market appeal to students (which has been seen to be misguided in many cases).

With levels of student demand remaining at historically low levels and enrolments correspondingly low across virtually the entire sector, it is unclear what the future holds for the IT disciplines in Victorian universities. The ongoing lack of student demand makes its future doubtful, unless it can re-establish the strong vocational connections which drove its initial emergence. Although IT education programs are unlikely ever to disappear completely from universities, without a turn-around in demand they may be forced to revert to the kind of supporting roles in association with other disciplines which they held in the CAEs.

Conclusions

This brief overview of the history of IT education in the Victorian higher education sector has highlighted a number of important features about the way in which has developed:

ISBN 978-963-89559-7-5

- Disciplinary legitimacy and recognition: Of the ACM's five core disciplines, only CS and CE can claim to have been universally accepted from the beginning as legitimate academic disciplines in the institutions covered in the study; the other disciplines did not achieve that status until the reforms to the higher education system broke down the barriers between 'academic' and vocationally-based IT. Interestingly, the vocationally-based generalist applied computing program which has been the most commonly offered type of program over the study period was the last type of program to earn disciplinary recognition from the ACM.
- Disciplinary diversity: The rapid rate of technological change and the changing demands of the student market have led to higher education institutions offering an extremely diverse range of IT-based academic programs. The programs in the disciplinary areas recognised by the ACM have been far out-numbered by programs addressing specific specialist aspects of IT and its applications.
- Volatility: There has been an extraordinarily high rate of turnover in IT program offerings, particularly in the changing student market place of the last 15-20 years. The speed with which institutions have been willing to dispense with IT programs suggests that the 'hold' which IT has on its place in the academic hierarchy is at best uncertain, and at worst tenuous.
- Vocational emphasis: After providing the dominant rationale for IT programs up until the abolition of the CAEs in 1990, the influence of vocational requirements has been significantly reduced and replaced by student demand as a key driver of IT program offerings
- Influence of external factors: 'Non-academic' factors such as the structure of the higher education system, government funding policies and market forces have played major roles in influencing the shape of IT education.

References

1. Aspray, W. (2000). Was Early Entry a Competitive Advantage? US Universities That Entered Computing in the 1940s. In *IEEE Annals of the History of Computing, 22(3),* (pp. 42-87).
2. Atchison, M. (2013). *Evolution of a Discipline: The History of the Formation and Growth of the Information Systems Discipline in Victorian Universities from 1960 to 2011.* PhD Thesis, Monash University.
3. Baron, G. and Mounier-Kuhn, P. (1990). Computer Science at the CNRS and in French Universities: A Gradual Institutional Recognition. In *IEEE Annals of the History of Computing, 12(2),* (pp. 79-87).
4. Benokraitis, V.; Bizot, B.; Brown, R. and Martens, J. (2009). Reasons for CS decline: Preliminary evidence. In *Journal of Computing Sciences in Colleges, 24(3),* (pp. 161-162).
5. De Ferranti, B. and Smith, B. (1976). *Computer education needs and resources at tertiary level.* Research report prepared for the Commission on Advanced Education, Canberra

ISBN 978-963-89559-7-5

6. Granger, M.; Dick, G.; Luftman, J.; Van Slyke, C. and Watson, R. (2007). Information Systems Enrollments: Can They Be Increased? In *Communications of the Association for Information Systems, 20(Article 41),* (pp. 649-659).
7. Guagnini, A. (2004). Chapter 15 'Technology'. In W. Ruegg (ed.), *A History of the University in Europe: Volume 3, Universities in the nineteenth and early twentieth centuries,* Cambridge University Press.
8. Metzger, W. (1987). The academic profession in the United States. In B. Clark (ed.), *The academic profession: national, disciplinary and institutional settings.* University of California Press.
9. Ruegg, W. (ed,) (2004). *A History of the University in Europe: Volume 3, Universities in the nineteenth and early twentieth centuries,* (pp. 1800-1945), Cambridge University Press.

ISBN 978-963-89559-7-5