An IT Support Capstone: Just Another Brick in the Wall

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The Diploma in Information Technology at Auckland University of Technology is a two-year undergraduate programme of study aimed at producing effective graduates in the areas of technical and user support. The programme has progressively developed from early origins in the NACCQ national curriculum's "blue book" to a fully internal programme accredited through the standard New Zealand university quality approval processes. A recent innovation in the programme has been the development of a capstone mini-project, with an "Information Technology (IT) support" focus. This paper outlines the motivation for the capstone project, its design and implementation, and the constraints within which it has had to operate. The paper also discusses key issues identified by the teaching team, together with the lessons learnt for overall programme design and review. A rationale for proposed changes at both the paper and programme level is presented and the case is made for the critical role of a capstone paper in an IT support diploma.

Keywords

Information Technology education, computing, capstone projects, work experience, co-operative education, IT technical support, user support, networking, diploma programmes, associate degrees.

1. INTRODUCTION

1.1 History of the AUT Diploma in Information Technology

The current diploma resulted from the restructuring of the 3 year National Diploma in Business Computing (NDBC). At AUT the NDBC offered three distinct study pathways: software support, networking, and software development. Students doing the software development pathway were required to complete a real-world project in their final year. This capstone project was an attempt at bridging the gap between academia and industry.

Since 1999,continuing curriculum development at AUT has led to migration from the national NACCQ curriculum to the implementation of a local degree, the Bachelor of Information Technology. This degree encompassed the former NACCQ software development study pathway. At the same time, the two year AUT Diploma in Information Technology was developed to cater for students pursuing the other two pathways: software support and networking.

1.2 Overall Programme Description and Goals of the Programme

The Diploma in Information Technology (D.InfoTech) is a 2-year, undergraduate programme of study at level 6 (similar to, but at a higher level than a U.S. associate degree). The aim of the programme is to produce IT Support graduates who have a sound technical understanding of information technology and its application to information systems in a range of contexts. The paper places equal emphasis on technical problem solving, professionalism, and the development of written communication and interpersonal skills.

In the first year students complete core papers relating to the fundamentals of information systems, hardware and software infrastructure, support of user applications and communication. In the second year, students may broaden their course of study with electives, or choose papers with a greater focus on networking, Internet support or user support. Table one below depicts the programme structure:

1.3 Development of the D.InfoTech Project

Initially, the D.InfoTech was devoid of a project paper. This was because historically the NDBC students who elected to take the software support or

Table 1: AUT Diploma in Information Technology Structure

SEMESTER ONE			
Programming Fundamentals	IT Concepts & Skills	Operating Systems 1	Communications 4
SEMESTER TWO			
Business Financial Systems	Hardware Concepts & Skills	Network Management 1	Software Support
SEMESTER THREE			
Suiteware	Network Management 2	Elective	Elective
SEMESTER FOUR			
Project	Help Desk & Service Provision	Elective	Elective
DIPLOMA IN INFORMATION TECHNOLOGY ELECTIVES			
Internet Technology		Operating Systems 2	
Database Management Systems		System Administration	
TPC/IP with Wide Area Networking		Needs Analysis, Acquisition & Training	
OTHER ELECTIVES			
Subject to Board of Studies approval			

networking pathways had tended to leave for employment after the second year. Instead of a project DInfoTech students were offered an Ethics paper and a Professional Practice paper. Although these were important topics in their own right, by themselves they were not sufficient to ensure student workplace readiness.

In semester 1, 2003 we introduced a Project paper into the D.InfoTech programme. The main aim of the paper was to act as a bridge to the workplace by developing students' self-confidence and professional capabilities, to integrate the skills they had already learnt and to extend their knowledge through exposure to new practices, topics or technologies. The goal of the bridging process was to produce independent learners capable of doing professional work. We saw the Project paper as the culminating capstone in the programme of work depicted in Figure 1.

We started by offering students the option of four different 'project types': Capstone, Research, Industry and Work Experience. The capabilities we expected students to gain from the project included teamwork, professionalism, work readiness, and industry experience.

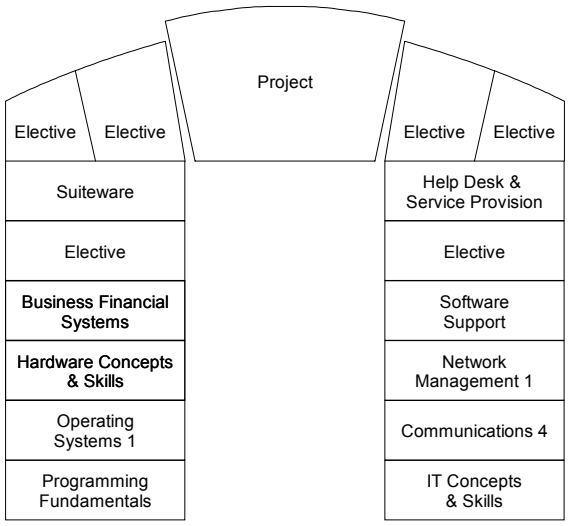

Figure 1. A project as a capstone in bridging from academia to work-ready graduates

2. MODELS FOR THE CAPSTONE PAPER IN THE SUPPORT DIPLOMA

2.1 Project types

As noted in 1.3 above we began by offering four different 'project types'. It took some effort to reach this point as there was very little relevant literature

about capstone project experiences for IT Support programmes, as opposed to software development programmes. The ACM guidelines for associate-degree programs covering this area (Klee et al., 2000) make no mention of a capstone project. Campbell (2002) does recommend that students in a two -year preparatory computer science programme " attain real-world experience through co-operative education, internships and other practicum activities". More typically Spooner (2000) refers to an "IT capstone experience" which relates to "all phases of an IT development project". Bridgeman (1999, 2000, 2003) has written helpfully on the evolution and assessment of capstone project papers, separating academic from production elements, but the models proposed again tend to be more geared towards software development projects. Of most value to us, Fincher and Petre (2001) offered several useful models in computer science projects, Clear et al., (2001) have discussed issues relevant to instructors, and our own student guides for our Business and IT degree students were useful sources from which we drew most of our inspiration.

2.2 Previous Models

Several other capstone or experiential learning models were considered, with each one contributing elements to the blueprint for this capstone experience in IT support. The final model then represents an amalgam of other course designs, tailored to this specific purpose. We now briefly describe the characteristics of each contributing model, based upon our experiences at AUT:

1) the NDBC capstone project (PJ300) at AUT normally involved students working in teams developing software for external clients (Clear, 1997), although Bridgeman (1999) has noted that a variety of different project types were undertaken across the country. This large project (approx. two thirds of a single semester of study), formed the core of the final semester's work.

2) the AUT Bachelor of Information Technology R&D Project is a similar size capstone course, normally undertaken by teams of students over a full year. Three classes of project are undertaken – commercial software development; commercial R&D (technology evaluation) and Research project. In addition to the NDBC project focus on delivery, it also emphasises reflection upon the context, the process, and the student's personal and professional development, somewhat akin to the 'project report' discussed by Bridgeman (2000).

3) The AUT Bachelor of Business Co-operative Education course is a full semester of individual study in a worksite, with both on-site and academic supervision. Professional, personal and workplace related goals are negotiated through a learning contract, and assessed through an oral presentation and a final project report.

4) The NDBC work experience (WX100) course covers a short period of individual study undertaken in a worksite, over perhaps two weeks during a break period, assessed via a subsequent written report. Work assignments have been very varied from hardware repair, manning a help desk, preparing user manuals, to developing small database and spreadsheet applications.

2.3 Comparison Between Classic Computing Capstones and their IT Support Variants

Based on this analysis we derived a composite concept for an IT Support Capstone course in the D. InfoTech. In table two below we compare and contrast the classic computer science project models with those we have identified for the IT Support Capstone. As can be seen there are several similarities in the chosen types of project, although the focus and content varies considerably.

While Table 2 compares the two classes of capstone project, there are key differentiators between a computing and an IT Support Capstone in several other dimensions. These are addressed in the following section and summarised in Table 3.

3. IT PROJECT PAPER DESIGN AND IMPLEMENTATION

3.1 Paper Design

The paper is offered in the final semester of the two year applied diploma programme. For full time students it is taken alongside 3 other papers, each one comprising 150 student hours. Before being admitted to the paper the students are expected to have gained a diverse range of practical and theoretical knowledge and support skills in hardware, software and networking.

This paper is often the student's first real exposure to a semester-long activity which requires project related skills such as planning, time management, communication and reporting skills in addition to the technical skills they have learnt so far.

3.2 Projects

Prior to the start of the semester a call goes out for potential projects. This results in a pool of candidate projects. In deciding which are suitable for our students the following factors are considered

- the level of skills of our students
- whether they are suitable for a small group (2-4 students)
- whether they are achievable within the time frame of 13 weeks
- the risk to the university and the client

The students are also given the opportunity to propose their own projects, frequently based upon an opportunity to contribute in their work sites, if they are working part time. These projects need to be carefully vetted to ensure that they meet the requirements of the paper.

A brief overview of each project is created to give students an idea of the type of work required and identify any specific skills that are needed. The students use these descriptions as a basis for indicating their interest.

3.3 Organisation

In the first class of the semester we introduce the students to the paper and spend some time talking about teamwork before asking the students to form their teams and indicate their preferences for the candidate projects. In particular we emphasise the need for:

- a common goal (that is we are content just to pass this paper, or we all want to achieve an "A')
- sound project scoping and definition
- teamwork
- good communication with team members, client and supervisor
- consistent work by all team members throughout the semester (following the project plan)

The supervisor negotiates the project proposal with the students. This process is akin to a learning contract. The supervisor needs to be satisfied that there is sufficient work in the project, that it is achievable and that there is a learning component involved that will challenge the students in some way.

Project supervisors are responsible for a class of students each, comprising several teams. Each team is assigned a sponsor, who may be either another lecturer within the School or an external client. The supervisor monitors progress of the teams throughout the semester and holds formal review meetings to ensure that the work is proceeding to plan. Supervisors liaise with the external clients to ensure that the client receives professional attention, and are responsible for marking the student's portfolios.

Many of the deliverables that the students are asked to provide are new to them. We have developed a student guide that outlines the requirements for particular documents. We have also developed a number of templates for the students to tailor to their use. This ensures that the students provide professional documentation to their clients and gives the students a guide as to what they need to include in these documents.

3.4 Allocation

Supervisors work as a team to allocate students to groups while taking account of the students' preferences, skills, past achievements and personalities. Once the groups are formed they are allocated projects.

In allocation of projects the supervising team consider the following:

- Students interest
- Previous academic results
- Skills and interests
- Size of project
- Communication skills
- Work ethic

These last two are particularly important in deciding which students work with external clients.

3.5 Assessment

Assessment is based on a project portfolio and a presentation of project results to the class and clients. Product, process and reflective elements are incorporated in the assessment programme. Fincher and Petre (2001) place special emphasis upon the value of reflection: "reflection on experience under-

Table 2: Comparison Classic Computer Science Capstones and IT Support Variants

PROJECT TYPE	CLASSIC PROJECT AIM	IT SUPPORT PROJECT VERSION
Research	Theoretically grounded project work contributes to a research discourse using appropriate methods and reporting.	Investigating and evaluation of an assigned topic resulting in a report and a poster. Less rigour in application of research method.
Product development – design and build	To design, implement and test a software product.	Usually not applicable but some small web site projects may be undertaken, sometime supported by pre-built components addressing more complex aspects of site development.
Software Engineering	To follow a software engineering methodology on a mid to large scales software engineering problem.	Not applicable.
Application Based	To create a software product within the context of existing software products, understanding, using and integrating various software effectively.	May develop integrated office automation applications, using Microsoft Office Suite, macros and some VBA.
Team Projects, Process Based	To experience group processes and team work in the execution of a development project.	Typically students work in groups of 2-4.
Capstone, Integrative	To integrate and consolidate acquired concepts and skills through use on project work.	Primary goal of the course, extending and integrating skills across full range of IT support roles from configuring hardware, networking components, operating systems and servers, through to training, developing user manuals, troubleshooting and providing help desk support.
Culminating Demonstrative	To demonstrate acquired skills.	May demonstrate ability to install operating systems, set up Web servers, LANs, configure network components, troubleshoot etc.
Industrial Projects	To glimpse the real world of industrial practice through interaction with industry on projects.	Relatively common--typically training, roll-outs and testing of hardware and software updates and extensions to existing configurations etc. Help desk and work experience assignments.

Table 3: Key Differentiator between a Computing and IT Support Capstone

CLASSIC CS PROJECT	IT SUPPORT PROJECT
Conducted in final year of three or four year degree programme.	Conducted in final semester of two-year diploma programme.
Software engineering project may be conducted in prior year in preparation for final project.	Preparatory experience currently provided through prior and concurrent course work.
Usually large proportion of a student's study load (often equivalent to a full semester of study over a year)	Small proportional allocation (one quarter of a semester's load)
Frequently full year duration	Single semester duration.
Analytical, design and Software focus.	Infrastructure or user support, operation or maintenance focus.
Students work independently with limited guidance from supervisors.	Student's work guided by templates (which they adapt to their projects) and are more tightly managed and at times assisted by their supervisors.
Frequently small groups of skilled supervisors assigned to teams or projects.	Small group of skilled supervisors assigned to student cohort (approx. 20 students). May work with colleagues as clients.
Supervisor may be concurrently project client (esp. in Software engineering or research projects)	Supervisor may not be concurrently project client.

pins the process of successful learning and is essential to the success of education." We also believe that not only is reflection on experience educationally valuable, but engaging in reflective practice engenders a mindset that is invaluable for effective professional performance.

Allocation of marks for projects has proved to be a challenging exercise. Because we are working with such different projects we have found that there is no common methodology such as a standard SDLC (Software Development Lifecycle) that will allow the projects to be broken down into common steps and have common deliverables. Consequently we have developed a process of agreeing with each team the way that their marks will be apportioned and also agreeing with them what their specific project deliverables will be. This is done when project proposals have been agreed. The traditional SDLC is used as a basis, but for each project the phases have to be redefined to fit the tasks involved.

The marking scheme has fixed elements that cover mainly project management activities and variable elements that are allocated on an individual project basis, dependent on the tasks involved.

3.6 Key Differentiators

Table 2 above shows the types of project offered by this paper and the pedagogical aims of each project type in comparison with the classical capstone project model. Table 3 below shows the differences in implementation between the classical model as often implemented in a three-year course and the implementation within our diploma programme.

4. ISSUES

The potential benefits from students participating in a project paper can result in trade-offs over the course of a project (Chamillard & Braun, 2002). Dimensions that may need to be considered are product vs. process, guided vs. independent learning, stronger vs. weaker clients, group vs. individual assessment. The objective is to strike a balance between maximizing the development of student capabilities while minimizing the inherent tradeoffs.

4.1 Programme and Paper Level:

In teaching the paper we found that students were clearly demonstrating their technical prowess, but development of their professional capabilities (e.g. project management, ethics and professionalism, client communication, etc.) was less consistent. The paper materials, structure, project types, etc. were reassessed and the delivery adjusted to focus on the capabilities in the graduate profile. The limited size and duration of the project also meant that the paper on its own could not hope to address the entire programme's learning goals. We also found that due to the variability of IT support projects, there were no widely accepted templates or methodologies to assist in guiding students in achieving their project deliverables.

4.2 Role Confusion:

Problems tended to exist in students confusing the roles of the project stakeholders, especially when definition of roles was blurred by lecturers having to double-up on roles, due to a lack of external client involvement. Students often found it difficult to take lecturers seriously as clients. This confusion was at its worst when lecturers attempted to assume roles of both project sponsor and project supervisor. But even when these roles were distributed amongst multiple lecturers, the confusion remained when students knew that the sponsor was also a lecturer with valued expertise on the topic at hand.

4.3 Managing Client Expectations:

Management of client expectations presented ongoing problems. At the start of each project, clients often need to be educated regarding the level of work that students of the Dip. InfoTech are capable of. Often clients, (typically in small business contexts) may themselves have limited IT awareness, and either under- or overestimate the students' abilities, requiring that project scope and deliverables be adjusted to fit. Students unwittingly contribute to the situation, often lacking the assertiveness to point out to their client that a given goal or strategy may be technically unsound. Furthermore, client expectations often need to be addressed during the course of a project, as obstacles such as a lack of necessary resources, may demand alterations of project deliverables. These issues are often an indirect result of poor project planning or specification, as confusion and misunderstandings usually follow from both clients and students.

4.4 Motivation:

The process from project selection/assignment to implementation consists of many milestones, mostly involving 'process' aspects of the project (Beasley, 2003), with some activities contributing to the final 'product' or deliverable. Students' tend to be most comfortable working towards tangible production related deliverables, and more reluctant to engage in the more process related activities such as planning, organizing, researching, progress monitoring etc. However, the assessment regime includes explicit assessment of the process related components of their work (e.g. teamwork, project control and relationship with their client are assessed, and need to be evidenced). Once this emphasis and the rationale are explained, students generally become comfortable and adapt their focus. In the Bachelor of Information Technology capstone we have addressed this tension between product and process by moving from an assessment regime based on lifecycle phases, to one based upon development activities. We have now also adopted this option for the IT support capstone.

4.5 Lessons Learnt:

Upon review, after completing the project paper, it was revealed that many students hadn't developed the capabilities defined within the D. InfoTech graduate profile. Several key professional capabilities, such as adaptability, project management, teamwork, ethics, communication, etc. were not being fully developed in our students. These were the abilities that industry employers insist upon in new employees. This helped to identify that the project paper was effectively too small to encompass all the necessary capability development, as well as provide enough time for students to perform and complete practical projects, leading to the recognition that there were significant gaps in the overall D. InfoTech curriculum. However it is unrealistic to expect one paper to remedy the deficiencies in student development over a whole programme of study. The corrective action within the projects themselves warranted finding effective solutions and techniques to help ensure that project students more closely reflect that of our graduate profile. Projects were monitored closely, and often supplemented with additional materials, on a case-by-case analysis, to ensure that students get the full experience, and the necessary capabilities that industry employers are seeking.

4.7 Plans for the future:

The project paper is continuously being reviewed for gaps in both design and delivery. Many such deficiencies have already been identified and addressed, but as old problems are reduced, new ones tend to surface. One major area that has been addressed several times since the initial development of the paper is the ongoing debate on how to develop the appropriate professional capabilities, without sacrificing time to complete a project's deliverables. Although sufficient class time exists to aid in the development of these capabilities, if project start dates had to wait for explicit teaching of these topics there wouldn't be enough time to follow through on the project itself. Therefore, we are proposing two project papers: a Case Study Project to be conducted in Semester 3, in which students would be able to develop their capabilities in a simulated scenario; and the Project paper, to be conducted in Semester 4, with the practical project being the primary focus. This would allow for students to develop the desired capabilities a full semester before they need to take on the responsibilities of performing on a project. A related programme review will more closely identify deficiencies and shape the development of student capabilities progressively from the inception of the D. InfoTech programme.

In addition to this programme review we intend to expand our formalised feedback process from clients upon completion of the project. The results from these surveys in turn will feed into further refinement of the capstone experience to the benefit of sponsors, students and the overall D. InfoTech curriculum.

5. CONCLUSION

In the process of incorporating a capstone paper into the AUT Diploma in IT we have gained a new appreciation of the value and purpose of a capstone paper. Since this Diploma is geared to producing graduates for careers in IT support, the traditional large computing capstone project models with a heavy emphasis on developing software (Fincher & Petre, 2001, Clear *et al.*, 2001) were not appropriate. The types of projects are more diverse, often smaller and more activity based, with

scope ranging from technical network and server installations and configurations, through static website implementations to training projects, developing help and user manuals and work experience assignments in which students might work on a help desk. Thus the design of the capstone needed to acknowledge that 'one size does not fit all', and accommodate diverse models, while giving some structure and guidance to students and supervisors. In reviewing the success of the paper after its operation for two semesters now, we are happy that it has improved the quality of our programme and it fulfils a vital function in the overall diploma. But we have concluded that we are trying to fit too much into one small paper, and we need a core preparatory paper in the previous semester, to better develop the broad set of professional capabilities with which we hope to equip our graduates. For us however, the key insight has been the immense value of the capstone paper both in ensuring that our students leave the programme properly prepared for the world of work, and as a diagnostic tool in identifying deficiencies in the overall programme by which we guide students to achieve the desired graduate profile.

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