

Teaching Computer Networking & Telecommunications: A Network Analysis and Software Development Approach

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ABSTRACT

A new information technology course – “Networking & Telecommunications” was introduced in Semester 2, 2000 as a part of the Bachelor of Applied Science (Software Development Pathway) degree offered at the Auckland University of Technology. As a follow-up on a paper presented at the 13th NACCQ conference here we analyse the delivery approach adopted for the course and evaluate its overall effectiveness. We begin with a section which reflects on how we transformed the learning outcomes into concrete assessment objectives. We then describe the teaching and learning strategies implemented, the resource development process (including course materials, and the setting up a customised networking environment) and more specifically the approach towards integrating a software development component and a network analysis component into the course fabric. The paper concludes with a section discussing the strengths and weaknesses of the course and the direction of its future development. The conclusions are drawn from data on course evaluation collected both formally (student

course evaluation forms) and informally - from discussions within the teaching team. The feedback from students and final examination results indicate that the development and the implementation were successful.

KEYWORDS

Computer networking, telecommunications, learning outcomes, summative assessment, evaluation

1. INTRODUCTION

In a previous paper Sarkar & Clear (2000) described the development of a new information technology course “Networking & Telecommunications” for the Software Development Pathway on the AUT Bachelor of Applied Science programme. The need for a background in networking and telecommunications concepts has been identified as an integral element of the graduate profile for the analyst/programmer or software developer. This is also supported by the NACCQ professional development working group (Clear, 1998). The networking & telecommunications companies, both nationally and internationally, have

a huge demand for graduates who are capable of developing software for their specialised technology domains.

The main objective of this paper is to report on the course delivery and its overall effectiveness. The paper is organised as follows. First we present learning outcomes and a weekly plan for course delivery. Then we describe the teaching resource development process. Approaches to integrating software development & network analysis components into the course fabric are described. Discussion on course assessment and students' performance in summative assessments is followed by a brief discussion and conclusion.

2. COURSE DELIVERY

2.1 Learning outcomes

The weekly plan for course delivery and the assessment structure are designed to meet the following four major learning outcomes. On completion of this course students will be able to:

1. Develop an in-depth knowledge of data communications and networking requirements including networking and telecommunications technologies, media, protocols, hardware and software
2. Analyse and design networking (both local and wide area networks) applications including network management, cost benefit analysis and evaluation of connectivity options
3. Explain the purpose and use of hubs, switches, bridges, routers and gateways
4. Discuss the issues related to security, privacy, and reliability in data communications networks including the Internet and Intranets.

2.2 Weekly programme

The course is delivered over 14 weeks, 4 hours class contact per week. Table 1 shows an overview of the weekly plan for topic delivery.

2.3 Teaching and learning strategies

The module is approximately 55% theory and 45% practical work. Approaches to teaching and learning have been designed to provide students with both theoretical and practical knowledge of networking and data communications including telecommunications technologies, hardware and software.

semester 2, 2000. We typically have two streams of about 22 students in each stream. The theory part is taught (2 hours per week) in a combined class whereas tutorials (2 hours per week) are conducted separately in a computer laboratory. Theory presented in lectures is enhanced via laboratory demonstrations, and practical exercises. The following teaching and learning activities are implemented:

- Lecturer-led discussion and lecture-style presentation of information
- Live demonstrations using available hardware and software resources
- Setting up customised local area net networks
- Small-scale software development for simulating and analysing network performance
- Demonstration of working software (prototype) by each team of students
- Company scenarios and problem based learning techniques
- Small-group discussion of supplied technical articles and practical exercises
- A guided tour of AUT local area networks
- Self-directed learning.

3. TEACHING RESOURCE DEVELOPMENT

Currently, two lecturers of Information Technology at AUT are involved in teaching and developing course material for the Networking & Telecommunications module. Based on the expertise and interest of each lecturer, the course development workload has been equally divided between them. The course development work includes lecture slides, handouts for students, Lab exercises/units, class revisions, and three summative assessments namely, two assignments and one final examination. The most interesting part of the course development is the setting up a customised server-based network (Novell Netware 4.11) for students to gain hands-on experience in network administration and management. We also developed lab units - for students to explore and gain a sound knowledge on TCP/IP connectivity and network security (see also Petrova, 2000). It should be noted that the course materials are being updating regularly to incorporate new development and latest technologies in the areas of networking & telecommunications. Besides our own course materials, the following resources are

The course was offered for the first time at AUT in

Week	Lecture	Topic	Tutorial	Summative Assessment	Learning Outcomes
1	Introduction to telecommunication developments, standard bodies, network hardware, software, and		Cost-benefit analysis (CBA) for Networking project applications		1, 2
2	Data encoding methods		CBA - continued	Ass# 1 handed out	2
3	Data communications media, Network topologies		Practical network design and analysis		2
4	MAC protocols: CSMA/CD, Token passing, FDDI, DQDB, Wireless LAN		Assignment 1- Workshop		2
5	Operation and use of repeaters, hubs, switches, bridges, routers and gateways.		TCP/IP – Internet connectivity practical		3
6	Network architecture and models. The Network layer		Network routing practical		2
7	Transport layer. Application layer		Network planning – (client/server interaction)	Ass# 1 due	1, 3 practical exercises
8	Network management		Revision test 1	Ass# 2 (formative) handed out	1, 2
9	Network management (continued)		Netware installation and administration		2
10	Factors affecting response time to users, delay-throughput performance analysis		Network performance analysis (using a LANALYSER package)		2
11	Network technologies: DSL/ADSL, ATM, Frame relay, High-speed networking		Network technologies – practical exercises		1
12	Internet and Intranets, Principles of cryptography, authentication and integrity, Network security		Implementing security: PGP		4
13	Keys. Security protocols, SNMP, Firewalls and application gateways		Assignment 2 - Workshop	Ass# 2 due	4
14	Revision test 2 (formative)		Revision		3, 4
15/16			Final Exam		1-4

Table 1:
Weekly Plan for Topic Delivery

used to support teaching and learning:

1. Library
2. Internet access and recommended web sites
3. Periodicals and magazines
4. MS Excel (including Solver)
5. SmartForce (a computer based training product)
 - Selected courses on Networking & Telecommunications
6. Demonstration equipment:
 - Voice communication over optical fibre
 - Wireless communication using Infrared
 - Hubs and switches, network interface cards
 - Cables (twisted pair, coaxial, optical fibre)
 - LAN analyser software

4. SOFTWARE DEVELOPMENT AND NETWORK ANALYSIS COMPONENTS

The software development component of the course has been incorporated in Assignment 2 in which students work in pairs and develop small-scale software for simulating and analysing performance of local area networks. Each team of students tests and demonstrates the performance of their prototype in the computer laboratory. However, students found this exercise quite challenging. The network analysis component of the course has been incorporated in Assignment 1. Students analyse a network based on a given scenario and produce a written report including a cost-benefit analysis spreadsheet.

5. COURSE ASSESSMENT AND STUDENT PERFORMANCE

Student performance on completing the module has been assessed by the three summative assessment items, namely two assignments and one written examination. The assignments 1 (individual) and 2 (group components) contributed 25% and 35% respectively, towards the final grade. The written examination (closed book, duration 2 hours) contributed the remaining 40% of the final grade. The minimum pass in each assignment and the final exam is 45% but an overall average mark of 50% is required to pass the module. More detail about the summative assessment structure can be found in

(Sarkar & Clear, 2000).

The grading scheme we use for this course (according to BAppSci - software development) is as follows: A+ (90-100), A (85-89), A- (80-84), B+ (75-79), B (70-74), B- (65-69), C+ (60-64), C (55-59), C- (50-54) and D (0-49). Note that A+ to C- are pass grades, and D is the fail grade.

In Figures 1-4 we present summary results of students' grade in summative assessments for semester 2, 2000. By comparing Figures 1 & 2, it is clear that students have done better in assignment 1 compared to assignment 2. This is probably due to poor programming background of some students. The performance in the final examination is lower compared to assignments. This is probably because the final exam is a controlled (closed book) assessment. As can be seen in Figure 4, the overall pass rate for this module is 98% and is consistent with other BAppSci modules.

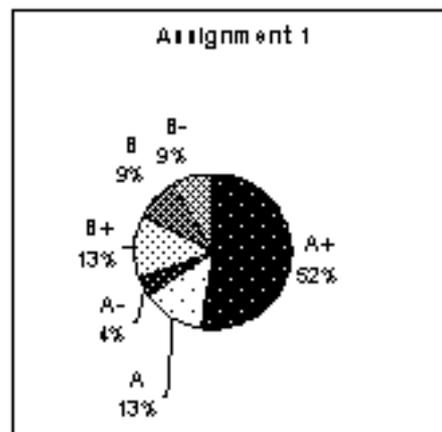


Figure 1. Student grade in Assignment 1

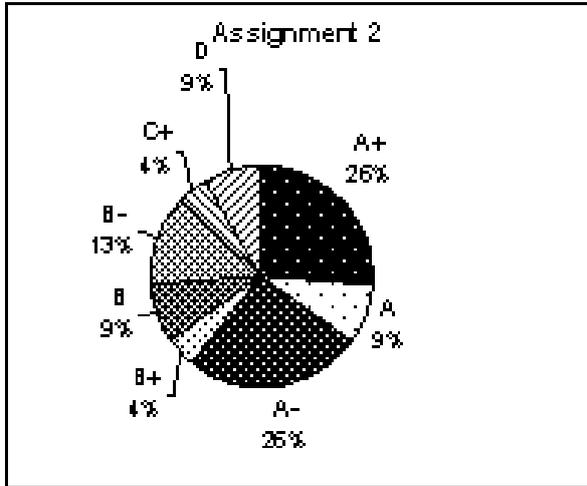


Figure 2. Student grade in Assignment 2

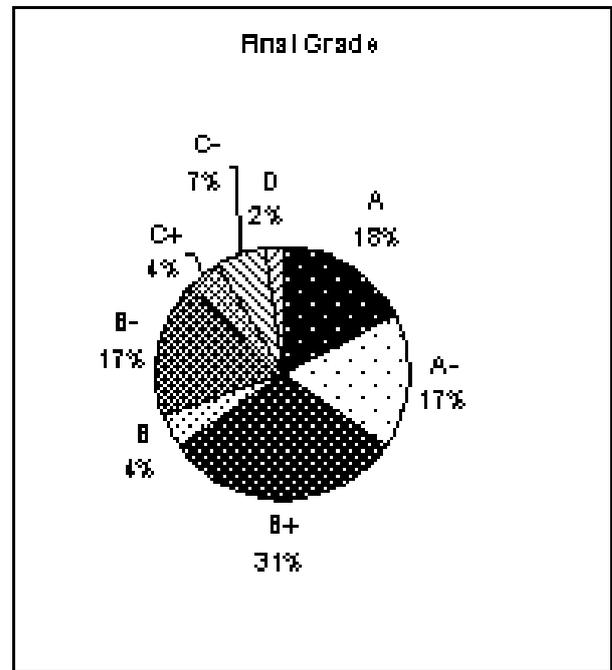


Figure 4. Student final grade

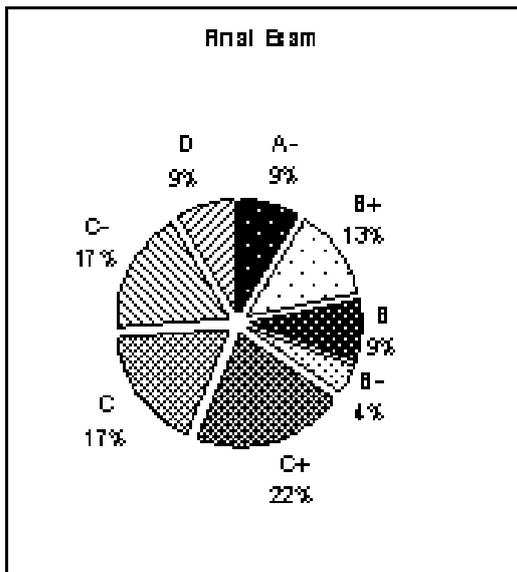


Figure 3. Student grade in Written Exam

6. DISCUSSION AND CONCLUSION

The module was evaluated first time formally by students and informally through discussions within the teaching team at the end of semester 2, 2000. Some suggestions for improvements have been already taken on board in Semester 1 this year. The data collected from students through course evaluation forms has been summarised and results forwarded to the board of studies, the program leader, and to each member of the team for reporting, auditing and further improvements of the course.

Network analysis and software development components have been incorporated in assignment 1 and 2 respectively. Due to limited resources, not all students got the opportunity for a hands-on experience in installation and administration of a server-based network. However, we are aware of the fact that a proper networking laboratory is required

for students to explore network administration and management.

Students appreciate the delivery and development work for this course and their feedback and final examination results indicate that the development and the implementation have been successful. Student comments are mostly encouraging and positive - "I think this module has been very well planned ...", "I am very touch[ed] by the lecturer who has spent enormous amount of time and effort to improve this module ...", "Good lab exercises and lecture notes" but sometimes critical – like "Very boring", "More practical work", "Perhaps cheaper textbook ...". We are seeking feedback regularly both from students and staff for further improvement of the course. We plan to introduce more business case scenarios in network planning, and more software development components – mostly in the area of network protocols, and also network security.

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