Miniproject-Based Learning as an Effective Tool for Teaching Computer Networks to Graduate Students

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ABSTRACT

This article reports on the experience of using the technique of miniproject-based learning (MPBL) as a key pedagogical method for teaching advanced computer networks within the context of a Master’s programme. A two-threaded approach was adopted. The MPBL thread within the course allows the students to gain practical experience and a deeper understanding of the key concepts of network protocols and technologies. The lecture thread uses face-to-face teaching, group discussion and class presentations to allow students to develop better communication and presentation skills. The effectiveness of MPBL approach has been evaluated extensively formally by students and by an external moderator, and informally in discussion within the teaching team. The implementation of the MPBL was judged to be successful because of the positive student and an external moderator feedback. Therefore, the authors propose that MPBL is a suitable pedagogical tool for the teaching of advanced computer networks to graduate students.

Keywords: computer science education; constructivism; postgraduate education; project based learning; network architecture; networks; wireless technologies

INTRODUCTION

Because of the high demand for computer networking skills in commerce and in industry worldwide, computer networking courses are becoming increasingly popular in universities, polytechnical institutions, and private training institutions across the globe. Despite this popularity, it is often difficult to motivate students to learn computer network protocols and technologies, because students find the topics rather abstract when they are presented using a traditional lecture format. Therefore, the authors have introduced miniproject-based learning (MPBL) as a key pedagogical method for the teaching of advanced computer networks. Most of the miniprojects are based on real-life scenarios that can be completed using limited
resources, such as modems, hand-held devices, wireless laptops and access points. A miniproject that a small team of students has completed in recent semesters involved experimenting with Wi-Fi (wireless fidelity) link throughput in an obstructed office environment. Another miniproject involved the student in implementing a software system for setting up a direct client-to-client connection behind a network address translation (NAT).

Research has shown that students learn computer networking better, and feel more engaged with their courses if they are given hands-on exercises and/or miniprojects that illustrate theoretical computer networking concepts (Midkiff, 2005; Richards & Waisbrot, 2002; Sarkar, 2006; Sarkar & Craig, 2006). Computer networks are described in many textbooks (Comer, 2004; Forouzan, 2007; Kurose & Ross, 2005), and project-based learning is discussed extensively in the computer education literature (Cassara, 2006; Dempsey, Anakwa, Huggins, & Irwin, 2003; Macias-Guarasa, Montero, San-Segundo, Araujo, & Nieto-Taladriz, 2006; Mese, 2006). Vaezi-Nejad et al. (2005) outline a number of approaches to teaching, learning and assessing postgraduate students who are studying telematics. Sarkar (2006) describes various hands-on laboratory exercises suitable for undergraduate computer networking courses.

Both open source and commercial simulators are available for developing network models (OPNET Modeler, 2007; Fall & Varadhan, 2007; Zeng, Bagrodia, & Gerla, 1998). Nevertheless, in completing a hands-on miniproject, the students gain first-hand experience that cannot be gained through computer simulation and modeling, and which plays a crucial role in motivating them to learn about computer networking. The MPBL approach to teaching advanced computer networks has been successfully applied for five academic years now in the ‘net-centric computing’ postgraduate course (computer and information sciences curriculum) at Auckland University of Technology (AUT). The course covers various aspects of network protocols and technologies, including wireless and mobile communication networks. The main contribution of this article is in the detailed analysis of the impact of hands-on experience (through miniprojects) on postgraduate student learning. The most innovative aspect of this article is the development and evaluation of specific miniprojects as an effective means of complementing the lecture content of the course. The academic context in which the miniprojects approach was implemented is described next.

**NET-CENTRIC COMPUTING: A POSTGRADUATE COURSE**

**Course Overview**

Net-centric computing is an elective course in the Master of Computer and Information Sciences (MCIS) program at AUT. This course, in which the aforementioned miniprojects are introduced, has a total of 150 hours assigned (24 hours of class contact and 126 hours of independent learning) and is delivered over 14 weeks (Petrova, Sarkar, & Buchan, 2003). The prerequisites for the course are both an undergraduate course in computer networks and an introduction to ‘research methods’. This first-year postgraduate course is intended to provide the students with an appreciation and understanding of two key areas: 1) upper-layer protocols; and 2) network technologies. The course goal is to produce postgraduates who will be able to work for networking companies in the contemporary business environment worldwide. One of the important aspects of the MCIS graduate profile is the development of excellent oral and written communication skills with the ability to work effectively as members of a team. The graduate profile emphasizes that an MCIS graduate will be able to: 1) learn independently through research and scholarship; 2) evaluate and critique the literature in a specialist field of study; and 3) carry out research in information technology (IT) and related fields, and integrate research findings with practice.
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