Chapter 21

Teaching Advanced Computer Networking: A Miniproject-Based Learning Approach

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ABSTRACT

This chapter reports on the authors’ experiences of using miniproject-based learning (MPBL) as a key pedagogical method for teaching advanced computer networks within the context of a Master’s course in Net-centric computing at the Auckland University of Technology (AUT). A two-threaded delivery approach was adopted that comprised an MPBL thread and a lecture thread. 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 the MPBL approach was evaluated extensively - formally by students and by an external moderator, and informally in discussions within the teaching team. The implementation of the MPBL was judged to be successful because of the positive student and external moderator feedback. Therefore, the authors propose that MPBL is a suitable pedagogical tool for teaching advanced computer networks to graduate and postgraduate students.

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 and private training institutions across the globe. Despite this popularity, it is often difficult to motivate students to learn computer networking, often because students find the topics rather abstract when presented using the traditional lecture format.
Research has shown that students learn computer networking better, and feel more engaged with their courses if they are given hands-on exercises and small projects that illustrate theoretical computer networking concepts (Midkiff, 2005; Richards & Waisbrot, 2002; Sarkar, 2006; Sarkar & Craig, 2006) in addition to the classic computer network textbooks, e.g. (Comer, 2009; Forouzanz, 2007; Kurose & Ross, 2008). Different approaches have been used in the past to improve the delivery of computer networking courses and address the issue identified above. For example, 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. Project-based learning (PBL) is another approach 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).

Building on the emphasis on student engagement which is central to PBL, the authors developed and implemented a variation of PBL approach called MPBL (miniproject-based learning) as a key pedagogical method for the teaching of advanced computer networks. In MPBL students are organized in teams which work independently on realistic projects with students engaged in activities involving scientific investigation, artifact design, and problem-solving. The MPBL approach is well suited to meet the course objectives. For example, MPBL approach demonstrates efficacy in the prescribed learning outcomes, and to satisfy student demand for developing the practical skills and capabilities required in the workplace (Petrova & Claxton, 2007).

In his review of contemporary PBL research, Thomas (2000) identifies five defining PBL features: ‘realism’, ‘centrality’, ‘student autonomy’, ‘constructive investigation’, and ‘driving question’. With respect to the first four characteris-tics MPBL and PBL are very similar. First the miniprojects used in the course are normally based on real-life scenarios that can be completed using limited resources, such as modems, hand-held devices, wireless laptops and access points. For example 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). Second miniprojects are used in the course as a central teaching strategy for learning new concepts and developing investigative techniques which constitute a significant part of the course assessment. Finally student teams work independently and without supervision in student-lead teams; students construct their own new knowledge as they go through the project steps, and at the end of the course are expected to be able to demonstrate that they have met the course learning outcomes by developing new understanding and new skills.

However the driving question in an MPBL project is not so much focused on a challenging cross-disciplinary or ill-defined research problem as in PBL but is rather practically oriented, with outcomes expected to have significance in the areas of computer network implementation or management. Although both open source and commercial network simulators for developing computer network models are available (Fall & Varadhan, 2007; OPNET Modeler, 2010; Zeng, Bagrodia, & Gerla, 1998), completing a realistic and practical miniproject gives students an opportunity to acquire 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 in ‘Net-centric computing’ – a postgraduate course which is part of the