THE INTERPLAY OF RESEARCH AND PROJECT ACTIVITIES IN COMPUTING

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One of the novel approaches we use to assist dissertation research in the School of Computer Science and Information Systems (CSIS) at Pace University is to create research supporting projects in some of our courses. We teach our dissertation students how to conduct research in a number of areas of computing, and our student project teams how to develop real-world computer information systems. In recent years, we have experimented with the interplay of dissertation research and projects created specifically to develop the supporting infrastructure for that research.

CSIS at Pace University has, or is connected with, several centers for research and development. These centers include the Center for Advanced Media [1], the Hudson Valley Center for Emerging Technologies [2], the Pervasive Computing Laboratory [3], and the newly formed Information Assurance Education and Research Center [4]. In addition to faculty research, we have several programs for student research. The Doctor of Professional Studies in Computing (D.P.S.) program enables computing and information technology professionals to earn a doctorate in three years through part-time study while continuing in their professional careers [5]. The M.S. in Computer Science program also gives students the option of completing a dissertation during their last year of studies.

In this paper we focus on our novel approach of supporting research through projects. Research is original, rigorous work that advances knowledge, improves professional practice, and/or contributes to the understanding of a subject. Research methods depend upon the nature of the research: controlled experiment, empirical studies, theoretical analyses, or other methods as appropriate. We require research work to be of sufficient strength to be able to distill from it a paper worthy of publication in a refereed journal or conference proceedings. Project work, on the other hand, uses known technology to develop systems according to specified requirements. We have our students serve the community (the internal university community, the greater university community, and the external non-profit local community) by developing real-world computer information systems for actual customers. We use real-world team projects to provide students with the educational experience of working together in teams, similar to what is done in industry, in order to design, build, and test computer information systems. Some of the project customers are faculty members or dissertation students (some working in collaboration with our research centers, other universities, or technology companies) who need supporting infrastructures to conduct their research. Thus, there is interplay between the project and research activities.

For dissertation work at the doctoral and master’s levels we introduce the student to the research process. Students are first given specific research papers to read and are expected to participate in discussions about the essence and context of the research area. Then, students are introduced to the literature search process and begin the individual progression toward a specific problem by finding several articles that relate to a research area of their interest. The steps of the research process are typically to find a general topic of interest and then a specific problem in that area, to review the literature to investigate previous approaches, to describe the problem and approach in a research proposal, to conduct the research (obtain data, develop system, run experiments, analyze results, etc.), and finally to document the research by writing a dissertation.

For the projects, on the other hand, the instructors solicit and interact with potential customers to set up new projects, work with the computer support personnel to create the project development infrastructure, and monitor the systems development process. Projects came from faculty and students interested in developing systems to further their research, from other departments or schools of the university needing computer information systems, from non-profit community institutions such as local hospitals, and from interests of the students. The instructor sizes and shapes each project to be an appropriate systems development experience for the students, resulting in a written project description that is posted on the course Website. The instructor then forms the student teams and assigns each team to a project.

The project development infrastructure is substantial. Since most of the projects use the client/server architecture, two NT servers and two UNIX based servers with Solaris-Oracle configuration, having access only within the university, provide development platforms for the student systems. The students are allowed to install software on these hosting platforms as required by their projects. After the development phase, the students move their application systems to a staging server having access from outside the university. The development and staging servers are independent and separate from the CSIS production servers so that students can not corrupt data or interfere with operations on those servers. The application systems use a variety of database-related software, including different scripting languages, such as Cold Fusion, PHP, Perl, and JSP, to communicate with backend databases in Microsoft Access, MySQL, MS-SQL Server, and Oracle. Some projects also use...
Java-related software, such as Java servlets, and Tomcat is installed to handle the processing of that code. Finally, those systems that we want to continue using, and that meet the quality standards, are migrated to production servers. For the project systems that are not web related other equipment is set up as required.

The development of the computer information systems requires a systematic approach by the students and proceeds through an evolutionary process model consisting of analysis, design, build, and test phases. Many of the research supporting project systems consist of a Web interface to a backend database using the client/server architecture. The simpler ones merely allow users to enter information into the database and retrieve the data for appropriate viewing. The more complex ones perform calculations on the data, which in some cases is substantial.

There are many benefits of the research and project activities. The research students learn the required individual skills necessary to conduct a research study. They learn how to perform literature searches to gain general knowledge about an area and to determine what previous work has been done on a specific problem. They learn organizational and critical thinking skills, how to be innovative and creative, and how to structure and perform their research studies. By serving as a customer of a student project that develops supporting infrastructure for them, they learn important management and leadership skills. Finally, in writing their dissertations they learn how to set their research in a proper context, to describe their methodology and findings, and to estimate its potential impact.

For the project students, as individual technologists, as team members, and as maturing professionals in computing, developing real-world systems for real customers is a stellar real-world learning experience. Individually, the students learn the technology skills necessary to develop real-world computer information systems. Through project reviews and team presentations, the students also learn about the various technologies used in other projects, and they especially appreciate the exposure to projects involving cutting-edge technology and research. Working in teams, the students learn fair-mindedness, intellectual humility, intellectual integrity, and the ability to work with others to produce useful systems and to take responsibility for them. Because most of the students are employed full time in various areas of computing, they bring their knowledge and expertise to bear in their project work, and by exchanging information, they learn from each other in this student-centered learning environment. As maturing professionals, the students learn how to act in the computing field not only as technologists but also as value providers. By working with real customers in developing their project systems and focusing on human-centered computing, the students learn important value skills [6]. This learning paradigm fosters lifelong habits for learning and the application of critical thinking and value skills.

Another novel approach we use is to have the students produce papers for publication. We encourage the dissertation student to produce a paper for publication, even if only for an internal conference or workshop, soon after the student obtains preliminary results. We have found this helpful because it is much easier to begin by writing a small paper than a large dissertation, it solidifies the problem statement and general approach with some preliminary results, it ensures that the student and advisor have a common understanding of the problem and methodology and that the advisor buys into the process, and it generates ideas and motivation for extending the work into a significant research study acceptable as a dissertation. We encourage the project students to produce a paper for publication, usually at student conferences like the Mid-Atlantic Student Workshop on Programming Languages and Systems, at the conclusion of the project. We have found that working to produce publications is a strong motivating factor for the students.

In summary, we have found an interesting and exciting interplay between research and project activities. Not only can appropriate structuring of the project activities can be beneficial to the research work, but the research activities often lead to interesting projects. Several case studies will be presented at the conference.