Changing the CIS Academic Culture: Using Senior Design Projects to Unify the Curriculum

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Abstract

Recently we initiated an effort to create a synergistic relationship between the senior design sequence and the sophomore software engineering course that resulted in a cultural change to our CIS academic community. Because of the enthusiastic response from students and faculty, we are extending this initiative to generate early interest among freshman and sophomore majors for electives in artificial intelligence and decision support. With hardware acquisitions obtained through an Instrumentation Laboratory Improvement (ILI) grant from the National Science Foundation, teams in the Senior Projects capstone sequence are preparing projects that will be employed in early courses in the curriculum. The projects will be used to provide students with insight about each of the elective areas of the curriculum through demonstrations and activities. This paper describes the five project initiatives and how the projects will be employed to generate interest in the elective areas.

Keywords: CIS curriculum, artificial intelligence, decision support, database, software engineering.

1. INTRODUCTION

Motivation

While students often view individual courses in isolation, curricula models are plans for the careful integration and the iterative development of concepts to higher levels of knowledge (Bloom 1956). The integrated laboratory experience (Doran 1994b, 1995, 1997a, Langan 1996), using a cognitive-based framework, illustrated how a hands-on approach can re-enforce topical contents to accomplish a depth-of-knowledge approach. Whereas this pedagogical approach serves the curriculum well at the introductory course level, the initial benefits disappear unless there is reinforcement throughout the remainder of a curriculum.

Although a cognitive-based approach is primarily focused on depth of knowledge, curricula should also provide for a breadth-first approach in some areas. Students who are exposed to the many facets of a curriculum can understand expectations of later courses and to make practical sense out of abstract concepts. This knowledge of future use of basic concepts and options of study can also serve as a motivation for students to build the necessary foundation to insure success later in a curriculum.

The use of collaborative, cooperative approaches (Daigle 1999, Landry 1997) and the use of informal and formal mentoring approaches (Daigle 1997, Doran 1994a, Doran 1996, Pardue 1991) are additional means of supporting student success throughout a curriculum.

The remainder of the paper will explore how we have attempted to further enhance the curriculum by addressing these issues. We will discuss the focus of a recently awarded NSF-ILI grant that extends the hands-on laboratory beyond the introductory levels to advanced levels of the curriculum. The projects from these upper level courses will be integrated back into the lower courses to challenge the "isolated view" of courses and to incorporate a breadth-first view in the introductory courses. Faculty mentoring of the development and implementation of the projects are critical for extending elective course experiences to meaningful applications.

2. *BACKGROUND*

A prior paper (Daigle 1997), described a novel approach to modeling relationships among courses in curricula. This approach involved establishing a formal relationship between members of a sophomore software engineering

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course and a senior design project course. The resulting "synergy by design" produced benefits for both classes: Software engineering students were introduced to the expectations of the senior design sequence early in the curriculum; senior design students were peer-reviewed. The early preview generated awareness in sophomores for the importance of intervening courses to prepare for the senior capstone experience. This paper describes an extension to the original approach to acquaint sophomores with the elective areas of the CIS curricula.

About the University of South Alabama

The School of CIS, one of nine academic units on the campus of the University of South Alabama, provides a choice of specialization areas for undergraduate students in: Computer Science (CS), Information Science (IS), Information Technology (IT) and Computer Engineering (CpE). Students of each specialization initially share a common core of courses in the first two years and then, after two years of courses specific to a specialization area, they share a common senior capstone experience. Specialization curricula are supplemented with elective CIS courses including artificial intelligence (AI), decision support systems (DSS), Advance Database and Real-time Computing. Typical enrollments for these elective courses are 20-25 per year. The senior capstone experience is a two-semester senior design project course sequence in which students (perhaps from different specialization areas) work in teams to undertake real-world projects and to produce production quality systems for a wide range of applications. Successes have been reported in the literature (Daigle 1997, Doran 1997b, Holt 1996).

Curriculum Structure and the Role of Electives

CIS curricula, such as the ACM model (ACM 1991) and the 1998 IS model (Longenecker 1996), address an agreed upon body of knowledge with activities that provide breadth and depth of knowledge. A specific implementation of these curricula result in a required core set of courses in the major as well as a set of required and supporting courses from other disciplines. CIS electives are an opportunity for a student to customize, at least a portion, of the curriculum in the direction of their special interests.

It has been observed through student advising that, in general, students decide to enroll in an elective course for a variety of reasons: personal interest in the course content, recommendations from members of a previous class or from an advisor, publicity by the instructor, perception of ease in grade assignment, perception of importance for job search, or availability in the course rotation. Of course, a selection based on interest is generally regarded as optimum. Once the class is

sophomore

formed, the instructor begins a familiar battle to generate student enthusiasm and motivation in students with diverse expectations who may not be truly committed to the study of the elective material. How does a student, immature in the curriculum, identify an area of interest early so that direction of special interest can be identified and nurtured early? We elected to develop projects in the senior design sequence, that could be used to provide insight, through activities and assignments in the freshman and sophomore courses for CIS elective courses such as Artificial Intelligence, Decision Support Systems, Advanced Database topics, and Real-time Computing.

The ILI Grant

In the past, the specific elective areas, AI, DSS, Advance Database, and Real-time Computing were taught with limited hands-on experience. The primary obstacle to extending the notion of "synergy by design" was the absence of sophisticated laboratories to provide advanced hands-on experiments for the upper division undergraduate students in the junior/senior electives and the capstone sequence. In order to meet the special resource needs to carry out the objective, several members of the School of CIS collaborated to prepare an ILI grant, which was subsequently funded by the National Science Foundation.

The plan for utilizing this equipment in the target courses will be accomplished as follows. Juniors and seniors who take elective courses will build upon these elective experiences in the senior design sequence, combining theoretical concepts and hands-on applications to prepare projects that can be used in the lower end of the curriculum. During the development of the senior project, sophomore software engineering students will be given class assignments, e.g. documentation review or test case development, that require interaction with senior design project teams. Selected core courses from the first two years would use the completed project for a breadth-first learning approach, directed to creating an awareness of the elective areas that relate to the project. The elective courses would make use of the completed project for a depth-first learning approach, examining the implementation strategies, replacing modules, extending the functionality of the project, or reverse engineering the project.

3. Methods

Four projects are under development in the senior design sequence; one project is under development in a directed study. A primary goal is to create a resource that could be used in the current curriculum and that could be further developed by students as senior projects, directed studies or other undergraduate research activities.

AI Projects
Two senior projects that directly focus on AI and Real-time Computing are under development: one involves simulation and the other specialized hardware.

RoboCup Simulation Project: The Robot World Cup Initiative (RoboCup) is an international research and education initiative to foster AI and intelligent robotics research by providing a standard problem, virtual soccer, in which a wide range of technologies can be integrated and examined. A senior project team composed of individuals, who recently completed the AI and Real Time courses, has committed to leveraging the RoboCup initiative to provide project-oriented activities involving AI. The project team will address problem areas that include improving the user interface to the RoboCup simulation system and developing a collection of decision support modules (FININ 1992).

Hexapod Walker Robot Project: Specialized hardware and accompanying controlling software present additional opportunities for examining AI concepts. The objective of a second senior project team is to create stand-alone tools and software libraries for activities to control a hexapod walker robot. Demonstrations would employ prepared activities for the hardware and collaborative experimentation with the controlling software (Flynn 1993).

Decision Support Systems, Advanced Database
The DSS part of the ILI grant focuses on the development of two major resources: a data mart using Oracle 8.0 and a medical decision support system.

The Data Mart Project: Inman defines Data warehouses as a "subject-oriented, integrated, nonvolatile, time variant collection of data in support of management decisions". A data mart is a subclass of the data warehouse that focuses on a narrow part of a business activity. The data mart, implemented using Oracle 8.0 made available through an academic agreement, will consist of an accumulated set of several years of sales records donated by a local direct mail order company. The goals of the senior project team are to establish the data mart, to implement an advanced visualization (multidimensional) application, to implement drill-down capabilities, and automatic updating when new records are added to the data mart

Medical Decision Making Project: The ILI grant also supports the development of resources for decision making curricula. This project, developed in collaboration with a local heart rehabilitation clinic, was initially explored in a past senior design project and is presently a subject of a directed study. The intelligent part of the project, a system to support medical decision making in risk analysis and therapy planning, involves the development of medical logic modules (MLMs) in a standard ASCII format called the Arden Syntax. An additional project is directed to the development of voice-recognition applications for use in rehabilitation. These knowledge-based tools will be linked to an existing patient database and will provide students with an opportunity to investigate how data and knowledge are linked to provide decision support.

A Hybrid Project
The last project we will describe, an intelligent web-crawler, is one that spans many core and elective areas in the curriculum: AI, Decision Support Systems, large-scale databases, Real Time Computing, and web-based applications. Because of the complexity involved in this project, it is expected to be an on-going project several years.
This project will focus on the issues relevant to existing web search tools: huge, unsorted databases with dramatic storage growth rates and impersonal, general query strategies that provide users with a large number, mostly irrelevant, web sites. By combining standard web crawling, artificial intelligence-based sorting and sifting of data, and a client-server database-centered user group subscription services, the senior design team will prepare a user profile management system coordinating personal web robots discoveries for group-oriented collaboration. This team's objective will be to work with faculty mentors to develop a vision and a framework for the project and to implement a web crawler, a prototype database, and a query/filter component for a limited number of specific web site types.

4. DISCUSSION

Students should be exposed to large complex systems throughout the curriculum. The laboratory experiences that the authors are directing will accomplish this at the breadth-level and depth-level of learning.

In the early part of the curriculum, the initial interactions with these systems will provide breadth-level experiences of many diverse topics. Demonstrations and assignments based on the projects supplement the depth-level experiences from the use of an integrated laboratory experience and a cognitive-based approach. Sophomore software engineering students will have assignments, such as design review and test strategy design, involving upper classmen working on real projects. These initial interactions provide an awareness of later course requirements and objectives. Specifically, the proposed projects will give students a pre-enrollment understanding of the topics in electives such as AI, DSS, or Advanced Database and the expectations of the senior design sequence. This look-ahead is a major advantage of the breadth-first approach to the curriculum. We feel that in this approach we can achieve the best of both the breadth and depth approaches.

Later in the curriculum, these projects can be used for depth-first experiences in the elective courses. Studying various aspects of the projects, reviewing alternative design strategies, and revising original code provides a higher basis for experimentation in these courses. The projects provide evidence to the maturing student of the importance of extending the cognitive-based approach to advanced courses.

Students in the senior design sequence interacting with sophomore software engineering students are accountable to their peers as well as to the course instructor. Moreover they have a mechanism for giving back to the curriculum which nurtured them.

Senior design students who have completed one or more of the electives were motivated to volunteer for a related project using the resources made available by the ILI grant. Based on the time invested and the quality of the specifications produced, these students have already demonstrated a high level of commitment to the projects.

The role of mentoring has expanded in this approach. Recruiting faculty mentors to provide guidance and expertise for the student projects is a standard practice. However, with encouragement from the instructor, senior project groups have extended invitations to underclassmen who expressed an interest in their project. Thus, in an informal way, a student-to-student mentoring has been initiated.

The entire process has led to a change in the learning culture of our CIS program. These projects have been allocated dedicated work pods and needed equipment and resources. As these projects are developed the students are keenly aware of the impact they will have on future students and courses in the curriculum. A consequence of this awareness is a better understanding of the contributing role of each course to the learning objectives of the curriculum. As discussed by Aiken (1991), this introspective view of all topics is the true capstone to the educational process.

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