

The Capstone Experience: Trials of a Joint Capstone Class for Computer Information Systems and Computer Science Majors

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Abstract

A capstone class can provide a quintessential experience for students in their program of study and is a critical component of any technology-based curriculum. This paper presents the experience of a joint capstone class for computer information systems and computer science majors. The article considers the circumstances that led to the consolidation, faculty considerations, and the experiences of students enrolled in the CIS 456 Project Management class during Spring Semester 2007. Discussion includes a description of the projects, an overview of the class content and activities, and a step-by-step account of the process students engaged in. Finally, project outcomes are presented with relevant observations concerning the challenges and obstacles students and faculty encountered during this project management experience.

Introduction

A capstone course provides a quintessential experience for students in their program of study and is a critical component of any technology-based curriculum. A project-based capstone class offers students an environment in which to learn and practice project management skills and techniques while participating in real-life projects. Students experience the challenges of defining open-ended activities and learn the art of managing technological projects. Designing a course that enables participants to work together and manage the ambiguity and uncertainty associated with complex projects requires careful consideration and is an important issue to those who teach capstone courses.

Of course, capstone courses are influenced by the broader academic environment and must adapt to changing organizational dynamics. The Computer Information Systems program experienced significant changes in 2006 with a decision to transfer the program to another department and phase-out the major. This article attempts to capture the considerations that led to a joint capstone class for computer information systems and computer science students, the impact it had on the class, and what was learned from the experience. This paper is the fourth in a series of articles [1-3] that examine intangible factors that influence student learning in a capstone class.

The content of this paper is divided into four parts. The first part provides the background and circumstances that led to the joint capstone class. The second part provides an overview of the capstone class to include content, activities, performance metrics, and a brief description of the projects. The third part presents a chronological record of the capstone experience with milestones and a description of relevant activities. The fourth part reviews project outcomes and offers relevant observations about the process.

Background and Circumstances

The decision to offer a joint capstone class for computer information systems and computer science majors stemmed from an extraordinary set of circumstances. On August 1, 2006, the Provost of the University of Wisconsin-Superior decided to move the Computer Information Systems program from the Department of Business and Economics to the Department of Mathematics and Computer Science and phase-out the major. Despite the phase-out, the faculty, courses, and assets remained intact and responsibility for the program was transferred solely to the Department of Mathematics and Computer Science.

A number of challenges faced the Computer Information Systems program which eventually led to the decision to phase-out the major. These challenges include,

1. Difficulty attracting students to the major due to poor economic conditions after the dot-com crash of 2000-2001
2. Managing a credit intensive major that requires students to be proficient in both technology and business

3. An increasing cost of college combined with decreasing scholarships and financial aid, and cut-backs in tuition packages for international students
4. Waning support for programs not identified in the University's mission and accreditation concerns over program proliferation
5. Internal departmental political factors that led to conditions where certain programs were no longer being supported

Although unfortunate, programs in a changing environment must adapt to the realities of a dynamic academic landscape.

On September 6, 2006 at the request of the Department Chair, the CIS-CSCI Integration Subcommittee was formed with the charge to create a plan to smoothly phase-out the Computer Information Systems major, maintain relationships with the Department of Business and Economics, and chart the future course of the program. The report and recommendations were presented to the Department in December 2006 [4].

Among other things, the report made the recommendation to streamline overlapping course offerings. CIS 456 Project Management and CSCI 499 Capstone Project were identified as candidates for merger, cross-listing, or to be offered in alternate years. The justification for the decision hinged on the potential to augment programming topics with issues related to management and business analysis. Since many factors were unknown, the merger of the course would be on a trial basis with implementation beginning Spring Semester 2007.

Class Overview

Originally, CIS 456 Project Management was designated as the capstone course for computer information systems majors at the University of Wisconsin-Superior. The class was scheduled during spring semester to seniors in the program and was generally the last class students took before graduating and entering the world of practice. Students who registered for the class were expected to have completed a majority of classes in their program of study, including foundation, general education, core business, and major specific classes [5].

The semester-long course carries a 3-credit designation in combination with a mandatory lab. Class and lab times were combined to form a two hour and fifteen minute period that met twice a week. Kathy Schwelbe's text, *Information Technology Project Management* [6], was used as the primary text for the class in conjunction with a supplemental reference by the Project Management Institute, *A Guide to the Project Management Body of Knowledge* [7]. In addition, class-specific materials were available online that included fact-sheets, checklists, forms, and document templates.

Tailoring CIS 456 to include computer science students in the capstone experience meant incorporating the academic preparation in their program of study. Foundation classes in the Computer Science major include calculus-based mathematics and programming. Major specific classes include networking, security, computer architecture, and the

choice of electives such as databases, cryptography, algorithm analysis and design, *et cetera*. Graduating computer science students possess a highly technical and analytically rigorous education [5].

Although students enrolled in the Computer Information Systems and Computer Science majors study different content, the strategy was to select projects that required the skill sets of both groups while retaining the project management framework. Students would have to work together, show initiative, communicate with one another, solve problems, think constructively, and justify their actions.

The class was organized using a matrix structure that integrates project activities with department services. Cross-functional teams formed the backbone of the organization creating a dynamic, goal-oriented environment needed to achieve project objectives. Initially, 15 students registered with approximately half majoring in computer information systems and half majoring in computer science. Three project teams and three functional departments with five members each formed the organization's structure.

Three projects were selected for the class, two development projects (Online Contact Management and Rescasa Web Development) and one research project (Campus Mobile Technology). Both development projects had well defined objectives and entailed building applications to satisfy a particular need. The research project was initiated to answer the question, "What mobile technologies are students bringing and using on campus?" As a research project, the approach to achieve the desired outcome was intentionally vague and left for the project team to define.

Class content was organized around two basic threads: the objective-oriented project that emphasized deliverables and the function-oriented departments that emphasized services. Project activities included the project kick-off, scope review, project review, and the final presentation. Department activities included the qualification exam, functional review, and group exam. Both threads ran concurrently with various activities and milestones intermixed throughout the semester.

In addition, there were a number of activities designed to help students improve their project management abilities. For instance: Weekly activity reports helped students learn time management skills. Status reports and presentations helped students improve verbal communication skills. Cover letters and resumes helped students with job application skills. Position descriptions helped students learn responsibility and assignment skills. And, reports and essays helped students develop their writing skills.

A comprehensive set of metrics that included individual activities, group activities, administrative activities, and peer evaluation and participation were used to measure student performance. The first three areas constituted 90% (each category worth 30%) of the final grade and were based on external measures of performance established by the instructor. Peer evaluation and participation contributed 10% to the final grade and allowed students to assess the performance of team members using predefined criteria.

Capstone Experience

The integrated CIS 456 Project Management class of 2007 began on Tuesday, January 23rd with a welcome letter presented to each student. Two attachments were included outlining the organization's structure and available positions. In the letter, students were asked to submit a letter of application stating their preferred project and department positions and a current résumé by Friday, January 26th. Prior to the deadline, the class met to discuss various strategies and approaches needed to write successful application materials for positions in business and industry in preparation for their application packets.

On Tuesday, January 30th, students received a formal letter indicating their position assignment. The organization consisted of three departments and three project groups. Departments were formed around the functional activities of project management to include Procurement and Human Resources (PHR), Scheduling and Risk Management (SRM), and Finance and Quality Management (FQM). Participants were divided equally among the three projects with attention to balancing diversity and talent needed to accomplish project objectives. In addition, standing and *ad hoc* committees were convened to manage organization activities throughout the semester.

Students were required to write position descriptions for their respective department and project assignments once the organization was populated. Position descriptions were processed for content and consistency through the newly formed Procurement and Human Resources Department. The deadline for submission was Tuesday, February 6th.

The project kickoff commenced on Thursday, February 1st. Jay Revering, ResNet Coordinator, represented the Rescasa Web Application project; Don Bremer, proprietor of Donneray Consulting, represented the Online Contact Management project; and the author represented the Campus Mobile Technology project. Each representative briefly offered an overview of their respective project and desired outcomes. In the second half of the session, project team members met with the project sponsors to share contact information, ask questions, and begin conceiving a plan to achieve project objectives.

Project and department teams began to meet on a regular basis after the project kick-off. The lab and a significant portion of class time were dedicated to meetings, and teams often met outside of class to work on particular tasks and assignments. In addition, weekly activity reports enabled members to track activity progress and status reports scheduled throughout the semester updated progress made toward completing project and department objectives.

The scope review was the first major presentation for the project teams. Groups were required to schedule reviews during class time between February 15th and February 23rd and prepare a scope review packet that consisted of a project charter, statement of work, a work breakdown structure with a tentative schedule, and a copy of their presentation slides. Only the Rescasa Web Development project team passed the scope review on their first attempt. The Online Contact Management and Campus Mobile Technology groups were asked to return for another try and succeeded on their second attempt.

After the scope review, a qualification exam was given on Tuesday, March 6th to simulate a professional certification exam. Members of the three departments created and disseminated learning materials to help each other prepare for the test. The exam covered the functional knowledge areas of project management to include finance, human resources, procurement, quality, risk, and scheduling and was divided into two portions. The general knowledge portion contained material the whole class was expected to know. The specific knowledge portion covered in-depth material associated with each functional department.

Functional reviews immediately followed the qualification exam and each department was expected to schedule a review between March 6th and March 17th. The review provides an opportunity to assess the competency of individual department members in their respective functional areas. Each department prepared a packet that contained a mission statement, services offered, methodologies, and a copy of their presentation slides. In addition, department members evaluated the presentations of their peers and performed a self-evaluation using a video recording of their own presentation. All three departments passed the functional review on their first attempt and only three students were invited for a second attempt to resolve minor deficiencies.

The qualification exam and the functional review presented special administrative challenges since they both covered topics often associated with normal business processes. For computer information systems students, this material was covered in prerequisite classes albeit in a piecemeal manner. For most computer science students, however, this was their first exposure to the business functions of project management. Therefore, additional care was needed to select questions that would challenge, but not overwhelm those with limited exposure to the material.

Project reviews were the next item on the agenda after the functional reviews. Project teams were required to setup meetings between April 3rd and April 13th in which to make their presentation. The review offers the ability to assess project progress and outlines a roadmap for the successful completion of deliverables articulated in the statement of work. For the presentation, the team prepared a packet that contained a final work breakdown structure and schedule, progress to date, a plan for carrying out the remaining activities, and a copy of their presentation slides. Each project team passed their review on the first try and only one individual was asked to return for a second attempt to correct minor problems.

Unlike the qualification exam and functional review, little administrative effort was needed to manage the project reviews. Specific project knowledge centered on group activities needed to complete project objectives. Even though the technical and business skill sets of individual members varied, the group typically divvied up the work based on individual strengths and interests. Modest coaching prior to the project review ensured team members were communicating important aspects of the project to the rest of the group. After the functional review, however, most were familiar with the procedure and knew how to plan for success.

Once the project review was completed, a group exam was given on Tuesday, April 24th. The two-part exam is collegial in nature and designed to strengthen team cohesion while evaluating project management knowledge. First, department teams competed in a challenge called *Put Your Best Foot Forward*. The objective was to formulate and present a response to address a hypothetical challenge a project might face. Teams were ranked based on the strategy employed and the content of their response. Second, project members played *Project Jeopardy* based loosely on the popular television show Jeopardy. The objective was to formulate a correct “question” in response to an “answer” provided in one of five project management categories.

As the end of the semester approached, project teams compiled and documented their work and recommendations into final reports [8-10]. The reports were reviewed for content and prepared for electronic distribution. The project teams presented their work, findings, and recommendations on Tuesday, May 8th in a public meeting that included project sponsors, faculty, students, and guests [11].

On Thursday, May 10th, the last day of class, participants engaged in a lessons-learned exercise to re-examine the process just completed. This session included a systematic review of the activities accomplished over the semester with discussion of alternate approaches in light of their experience. An economic assessment of the monetary value of their work was conducted based on similar projects found in industry or funded by external grants.

Finally, class members were asked to submit a formal peer evaluation and an essay describing their experiences in class. The peer evaluation required participants to objectively rate the performance of members in their project and department teams. The essay gave students an opportunity to tell their story about what they did and offer advice to future students. All the essays were compiled in a document called the *Project Management Cookbook* [12].

Project Outcomes and Observations

Although three projects were selected for the capstone experience, they fell into two basic project categories—development and research. The Online Contact Management and the Rescasa Web Development projects were development projects with well defined goals and outcomes. The Campus Mobile Technology project, however, was a research project that left the means to achieve the results to the project team. Considering project outcomes by category offers insight into how students from the different majors reacted to the challenges posed.

The objective of most development projects is to create a tool or system to accomplish some function. Usually there is a problem to be solved that entails performing a needs analysis and defining requirements and specifications. Although development projects can be extremely complicated, development models lend much needed structure toward managing project uncertainty and ambiguity. In this respect, the Online Contact

Management and Rescasa Web Development projects had many similarities including the aim to create software applications to solve organizational problems.

The Online Contact Management project sought to upgrade an existing timesheet application to better serve the needs of the employees at Donneray Consulting. The original application was developed in an *ad hoc* manner and had several deficiencies. Initially, the project team wanted to begin coding a new application without considering commercial alternatives; however, the author advised the group to explore commercial applications to see what was available before committing to an in-house solution.

The team formulated a list of common evaluation criteria and identified five alternatives—Web Time Sheet, Dovico Timesheet, Collect Time, Time Clock Online, and Time Ledger. Based on the common evaluation criteria, the feature set of Time Clock Online provided the greatest coverage and ranked highest in the student analysis. However, the product identified was also one of the more expensive applications available. In normal circumstances, the option to pursue the commercial application would have been sufficient. However, two students on the team worked for the sponsor and were willing lead development of a custom application without a significant time or cost commitment. Therefore, the choice to create an in-house application was made.

The new application employed a three-layer architecture consisting of a presentation, business logic, and data access layers. The architecture was created using Microsoft's .NET 2.0, ASP.NET, Visual Basic 2005, and SQL Server technologies. This approach enabled a clear separation between layers to enhance maintenance, upgrades, and security. In addition, the project team considered the personnel and procedures needed to maintain the system, risk associated with implementing the system, and user training that included a basic user manual to operate the system.

The Rescasa Web Development project also sought to upgrade an existing database application to better service Residence Life, the department responsible for operating campus residence halls. The current application suffered from functionality, security, and documentation deficiencies. Preparation for the upgrade was initiated well before the start of the project and therefore investigating alternative applications seemed inappropriate. However, web technologies and database systems in which to host the application remained in question and the project team considered various alternatives.

The project group created a list of preferred features for web technologies and database systems. Web technologies considered included ColdFusion, PHP, and ASP.NET; and database systems evaluated included Microsoft SQL Server 2005 Express, Oracle Database XE, and MySQL 5.0. No particular system was recommended; instead, comparison charts were created illustrating the feature sets of each technology for future reference.

Prior to the start of the project, the ColdFusion security framework had been adopted to develop a more robust and security conscious application. Database schemas were added to include new user login and authentication functionality, and incident and weekly reporting mechanisms. The project team employed W3C design considerations for future

compatibility and discussed how the new login and reporting functionality operated. Coding guidelines and conventions for HTML and CFML, along with coding and commenting conventions for readability were included.

These two project teams adopted similar strategies for tackling project objectives. Groups divided and assigned tasks based on the discipline specific skills members possessed. The biggest challenge was getting team members to overcome their provincialism in thought and action and open a dialog that incorporated new approaches. For instance, computer information systems majors shied away from programming and in-depth analytic tasks since this was not one of their strong suites. Computer science majors avoided business processes like considering alternative approaches before selecting a course of action preferring to pursue the first feasible solution available. The challenge was getting individuals to see beyond their immediate specialty and learn cross-disciplinary skills.

Learning to communicate with others that have different strengths often means learning to accept one's own limitations and overcoming the insecurity and self-confidence issues associated with not knowing. Communication problems are generally easy to spot and often manifest themselves in the form of arrogance, avoidance, and withdrawal. One duty as the instructor was to ensure a sustained dialog among team members. This involved coaching communication skills and helping group capitalize upon their collective talents.

An effective approach to encouraging team cohesion is to engage in role playing in the classroom. In addition to facilitator and enabler, instructors can play the role of boss and supervisor occasionally taking a respectfully adversarial stance. This often stimulates student teams to pull together to fend off external inquiry and review. Discussing this approach in advance lets students know its coming and why it is useful as a tool to motivate. Of course, the author recommends that a suite of roles be learned and applied in moderation when needed.

The Campus Mobile Technology project originated from an interest the author had about student use of mobile technology and what the University could do to utilize devices students already possessed. Up to that point, little had been done to find alternatives to the concept of a "laptop campus." The University of Wisconsin-Superior serves an economically depressed region and requiring students to purchase or lease a laptop adds another expense to an already constrained budget. However, if we knew what kind of mobile technologies students possess and use then it might be possible to develop applications that support that technology.

As a research project, the team members needed to identify and adopt an approach that would achieve project objectives. Research projects in past classes challenged students to think holistically about the outcomes and how they would like to achieve them. Students are given considerable latitude to pursue the project as they see fit, however, this independence is confusing at first. Once students begin to see the broader picture, they find that research projects offer a degree of freedom and creativity structured development projects lack. This is an appealing prospect for students that like this type of challenge.

Once the team began to feel comfortable with the research process, they developed a plan to answer the question, “What mobile technologies are students bringing and using on campus?” They decided to use their resources to gather data by soliciting feedback from focus groups using a questionnaire prepared in advance. They formulated the research methodology and submitted an application to the Institutional Review Board (IRB) for permission to run the study. The IRB approved that application with only one minor modification and the project team executed their plan in mid-April 2007.

The author’s only observation about this group was that they appeared to have difficulty thinking beyond a “development style” solution to the problem. The team possessed very strong analytic thinkers that seemed perplexed with open-ended problems. The inability to grasp the nature of research led to some frustration—which is not unusual. Even with coaching, the team did not seem able to utilize their analytic skills to pursue the more technical aspects of the project that may have included an analysis of mobile technology. Nonetheless, the project team pulled together and did an outstanding job formulating a research plan and seeing it through to completion.

Beyond the immediate project outcomes, two unforeseen factors influenced the joint capstone experience and impacted the administration of the class. First, the author was not equally familiar with both groups of students. The immediate consequence of this imbalance was the perception of favoritism toward computer information systems majors. Despite working very hard to ensure equity, computer science students often gave the impression they were being treated differently. In addition, it was difficult to assess individual computer science student personalities and interpersonal skills without having them in prior classes. This knowledge is critical when populating an organization since it is important to avoid placing individuals with conflicting personalities in the same group.

Second, social interactions and communication pathways increase in number and complexity. Prior to the class, the author’s observation was that computer information systems and computer science social groups do not seem to interact. On occasion, these two cliques exhibited condescending behavior toward each other whether due to competitive rivalry or for other reasons. Although this pattern diminished as the two groups began working together, the author found it challenging to manage the two distinct political factions. In addition, computer science students communicate with and leverage different faculty in the department to promote their points of view. This led to indirect channels of communication within the department that had to be managed separately.

Despite these particular challenges, the author found the experience to be very positive. Combining two groups of students with different skill sets and abilities in a single class leads to a dynamic and stimulating environment rich with learning opportunities. Although student reaction was somewhat mixed, many of the problems stemmed from the author’s own inexperience managing a capstone class for two distinct majors and the trials of trying something new. It is clear, however, that some computer science students would prefer a traditional capstone class that concentrates on programming and analytic skills without the stresses associated with project management. The decision to pursue this option was taken in the following academic year.

Summary

This paper considers the trials of a joint capstone experience for students in the Computer Information Systems and Computer Science majors at the University of Wisconsin-Superior. The capstone class of 2007 provided an exceptional opportunity to observe how students achieve project objectives while striving to learn project management skills and practices. The article describes the background and circumstances leading to the joint effort, a class overview that details course structure and selected projects, the capstone experience that chronicles the timeline and activities in the class, and project outcomes and observations that illustrates student effort and the obstacles they overcame.

This work recognizes the importance of adapting to a changing academic landscape where trying new course configurations leads to unexplored opportunities and challenges. Even the most experienced instructors have difficulty anticipating the all circumstances that give rise to unplanned events and behaviors in a capstone class. Yet, acknowledging these conditions is an essential part of capstone pedagogy and course design. Recognizing the intangible aspects of education and openly discussing classroom experiences offers insight into the mechanisms that contribute to a successful learning environment.

Finally, this work continues to add to the body of knowledge regarding capstone experiences; however, there is more work that needs to be accomplished. Further studies may include guidelines that enable departments to plan hybrid capstone courses in a changing academic environment, and specific techniques that moderate undesired behaviors and promote desired cooperation between individuals with different skill sets in a project management environment.

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