A Capstone Course Sequence in Information Technology

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Juniata's capstone course in information technology, Innovations for Industry (I4I), is a three semester sequence. Information Technology majors take the first course during their junior year, which is comprised of three credits of project management and one credit of project experience. Then as seniors they take four credits of I4I project experience in both the fall and spring semesters.

In I4I, students are organized into groups to work on IT projects for both local clients (typically central Pennsylvania), and remote clients, who are accommodated though teleconferencing. These clients include for-profit business, non-profit organizations, service organizations and government agencies. The student groups function as project development teams, applying IT solutions to opportunities and problems specific to their clients. Over the course of three semesters the students are exposed to many aspects of systems analysis, design, development, and implementation, as possible, in addition to applying project management tools and techniques. Student roles in the projects include: developer, designer, project manager, and tester/quality controller. Minors in Information Technology take the first course, typically in their senior year, while students from other disciplines, such as computer science, business, or communication might be recruited to serve as specific content experts on teams.

In addition to the pedagogical benefits of a capstone course, students have found these projects often lead to full-time employment, as well as internship opportunities for underclassman. Juniata benefits by being able to showcase its Information Technology students, as well as having a mechanism for feedback from the clients on both the skill sets of the students and possible modifications to the curriculum.

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Background

Capstone courses provide students the opportunity to further their knowledge and apply it in a context outside of the classroom[1], and the percentage of students with an opportunity to participate in capstone courses has risen dramatically[2]. The open-endedness of opportunities in a capstone course provide value for the student, but challenges to the faculty designing and leading them[3]. There is no standard for capstone courses, and even within the same major a successful and useful capstone course might be quite different between institutions[4]. This paper will explore Juniata Colleges' capstone course(s) in Information Technology.

Juniata College is an independent, co-educational college of liberal arts and sciences founded by members of the Church of the Brethren.

The Juniata college student population is between 1400 and 1500 students. Juniata has between 130 and 140 faculty members with a 13 to 1 student faculty ratio. Juniata's 4-year graduation rate is 95%, 71% of the students do an internship, and 40% of the students have a study abroad experience. The average class size is 14 students. Students have a Program of Emphasis (POE), rather than a major, with the option to design their own course of study, with the guidance of two advisors. 41% of the students design their own POE.

Department Background

The Information Technology and Computer Science department has its roots as the Mathematics and Computer Science Department.

In 1998 Juniata was presented with a generous financial gift and challenged to develop a unique Information Technology (IT) program consistent with the liberal arts mission of the college. The initial goals of the IT program were to:

- be interdisciplinary by building on the liberal arts tradition of the college and collaboration among existing departments
- combine communication, business, and problem solving skills with a solid technology background in our graduates
- ensure significant industry experience into the program
- develop management skills for success in leadership roles

- develop an entrepreneurial mindset so that a student could create an information technology product or service and successfully market it
- eventually integrate information technology into all programs of the college

The IT program was formally launched in the 2000-2001 academic year. The program is deeply rooted in the liberal arts tradition of the college and remains a collaborative effort among faculty from IT and CS, Accounting-Business-Economics, Communication, Environmental Science and other departments on campus. The broad perspective a liberal arts education provides helps our students see the impacts and applications of technology on a global scale.

Course Background

Innovations for Industry (I4I) began as part of the original IT curriculum at Juniata College. While it has evolved over the 9 years of existence, the initial concepts remain the same. The course is comprised of 12 credits spread over 3 semesters. Students take the first 4 credits of the course during their junior year and the final 8 credits during the fall and spring of their senior year (typically). I4I has always involved working with external clients under close faculty supervision. Students are split into teams of 3-5 students with one student functioning as the project leader. The project leader is typically a student in their 3rd semester of the course.

Innovations for Industry I

The first course in the I4I sequence is typically taken during the junior year. This portion of the course has probably evolved the most. Currently it is split so the students have 3 credits of project management and 1 credit of project experience. The first semester students are assigned to a project team, along with the second and third semester students, but they have additional responsibilities outside the project. They meet one or two times a week as a class with a faculty member to study project management techniques. The 3 project management credits consist primarily of applying techniques studied in class to their assigned projects. As group members, they create and maintain the appropriate project management documents that comprise the project management plan.

The class is run as a seminar class with significant time dedicated for the students to present their documents and have them critiqued by the other students and faculty present. In addition to project management skills we also discuss ethics as well as resume building.

The first semester students earn the additional 1 credit for their involvement on the actual project. They are expected to be a working contributing members of the project team, even though the time they have to commit to the project is less than the upper level students. They typically are the leads for documentation, completing the required project documents, in addition to contributing to the actual work necessary for the project.

Innovations for Industry II

The second course in the I4I sequence is typically taken in the fall of the senior year. This course is 4 credits and dedicated to executing field projects under the direction of faculty. Students may assume different roles in the projects including developer, designer, project manager, and tester/quality controller. As students move through the course sequence, they might move from roles in project implementation to roles in project planning and management to roles in selecting from among alternative projects.

Innovations for Industry II requires a high degree of participation and responsibility by the students who are responsible for their own experience in the class. The course requires accountability by the students to produce professional quality work for actual clients; a few students are not mature enough for this challenge and they struggle. The number of students that struggle is small, and fortunately many learn from their mistakes in Innovations for Industry II and grow and correct the problems when they take Innovations for Industry III. Most of the issues involve time/project management and providing a consistent and steady effort each week.

It is very satisfying for the faculty to see the growth in the students between Innovations for Industry II and III. Many students have never been exposed to the size of the projects we complete in the courses and do not understand the time/project management skills required. There are students that really struggle in their I4I II project and then have a great experience in I4I III.

Innovations for Industry III

Students typically take Innovations for Industry III in the spring of their senior year. It is very similar to their experience in I4I II. Projects are typically 2 semesters in duration, so often I4I III is a continuation of projects started in the fall semester. This allows students to have the real life experience of having some turnover in group membership, as students leave the project and new students join the project between the fall and spring semester. There are some 1 semester projects which start in the spring semester also.

Students in I4I III are expected to demonstrate the same, if not more, levels of maturity and responsibility as in I4I II. At this point most students are fulfilling the role of either project or technical lead

in a project. While inevitability we see some "senioritis" in the spring semester, in most cases their sense of commitment to the client overcomes this problem.

Project Team Selection

The students in Innovations for Industry II and III are responsible for choosing the project teams.

Clients provide a one page document outlining the projects. This document includes a description of the project, the deliverable, technologies used and the learning experience provided. The students in the class provide resumes. On the first day of class the II and III students get together (without faculty representation) and pick the project teams and leaders for each of the projects.

This modification was introduced in fall 2008, and while the teams were not always divided as faculty expected, the student ownership of the projects was dramatically increased. The students felt greater ownership of the projects than in previous semesters.

While there is definite risk in this approach we feel it is a unique approach and the risks are well worth the benefit of project ownership by the students.

Class Governance

Prior to 2008 a faculty member from the department was assigned to each team in I4I. While this was a great theoretical model, in practice it was a heavy load for the faculty. Due to sabbaticals, in the 2008-09 academic year, just one faculty member ran the class, and now in 2009-10 the course is being team-taught.

One extremely valuable tool for managing the class and facilitating progress on the projects is the Friday status update meetings. Each team answers the following questions:

- What did you get done this week?
- What are you going to get done next week?
- Is there anything in your way?
- What did you learn?

This is done in a quick, round-table fashion. While originally envisioned to help one faculty member keep track of all the projects, other benefits became obvious. Students felt more involved with all the projects, and students from one project are struggling with understanding a new technology, they are generally able to get useful advice from students on other projects. These meetings also facilitated the goal of "cross-pollination" between projects. There is a motivational benefit too, since it is easy for teams to determine if they are falling behind other teams and needing to pick up the pace. Finally, the Friday meetings are an opportunity for teams to present their product and solicit feedback from the other students.

In addition to the weekly meetings each team is assigned a white board in the I4I room. On the white board they post their milestones and track progress against the milestones. While a great tool for faculty members to keep track of the progress it also created a bit of competition between teams to complete milestones as scheduled.

Grading

Grading in I4I is probably one of the biggest challenges in the course. The faculty strives to minimize the subjectivity and assign grades as fairly as possible. This is complicated since each semester the projects are always very different and the clients are always very different. Consistent feedback, similar to employee evaluations, helps alleviate student concerns, especially by providing them with a mid-term grade range. Typically this interaction is like, "If grades were assigned today, you would have earned something between a B+ to A." We also provide them feedback for areas to improve in.

Since we like to run I4I as if it is a business entity, it really does not seem appropriate to grade everything along the way. For instance while we provide feedback on the presentations, we do not grade them (much like a business). The documents along the way are not graded, only feedback provided, the only tests that are given are in the Project Management class. So this is a very different model for the faculty and students.

Many metrics are considered during calculation of the final grade. The primary metric is the outcome of the project itself, and how well it was managed along the way. We also ask the clients to complete a feedback form on the students and project. The students do peer evaluations as well as a reflection paper. All of this is pulled together at the end and analyzed to give the students their final grade in the course.

While having a rubric would be helpful for both the faculty and students, the projects are so varied it has made development of a rubric impossible.

Clients

While similar courses at other colleges require the clients to contribute to participate in their programs, Juniata does not. This is an important part of our program, we look carefully for clients that are willing to mentor the students, not just get "free labor". Often our clients invest more in the projects than they receive in return. These are the type of clients we greatly value, those that want to give back to the students as well as receive from the students. This is an important part of our I4I experience, we fear that adding the payment dynamic would change the experience drastically.

In the first half of the semester, client meetings are held every 2 weeks, and then after mid-term they are held weekly. These meetings give the clients frequent interactions with students, and provide valuable mentoring opportunities. Generally, clients stay involved in the program for a long period of time. In fact one client has been sponsoring I4I projects for every semester since 2001.

The Projects

The projects themselves are quite varied and provide differing challenges for the students. Some projects are very technically challenging and others the requirement development is more challenging than the technical development. Some are moved immediately into production, others are more of a proof of concept. Just to provide an idea in the spring 2009 semester we tackled four major projects and three smaller ones:

- Automation of arrest reporting for a local law enforcement agency
- Providing a visualization of email destinations for an email marketing company
- Developing a proof of concept for securing web services for a software development house
- Creating a method for providing insurance quotes to independent insurance agents through their existing software base

While these are very brief descriptions of very complex projects it should provide an idea of the breadth of the projects.

Outcomes

Over the past 5 years we have had approximately 25 different I4I clients. One client has been with I4I each semester for the past 5 years. Again, we try very hard to find and retain I4I clients with good mentoring attitudes towards the students. We also look for clients that use a life-cycle model in their development process. The concern is not the type of model, some use a 1-D, 2-D or agile process, but having the students apply a life cycle model gives them valuable experience for entry into the workplace.

In the spring of 2008 we surveyed IT graduates. While the survey was not done to gather research data one question asked the students what in the IT curriculum prepared them most for the work place. A majority of students pointed to the I4I experience. We additionally perform senior exit interviews, these are one-on-one interviews with alumni from the department, and again I4I is always ranked highly amongst students.

Another area we can examine for outcomes are the student employment opportunities that come from I4I. In the spring 2009 I4I class we had four senior IT students in the class. Three of the 4 students had job interviews with their clients. Two were given job offers; one accepted and is now employed by their I4I client. The client lead on two out of four of the spring 2009 I4I projects was a former Juniata Computer Science or Information Technology student. As our IT alumni network expands we continue to increase the interest in I4I projects in new organizations through alumni. This has also helped expand our range outside of central Pennsylvania.

Conclusion

In conclusion I4I has been a powerful class for students, faculty and clients. We even have a client that uses the projects as a training ground for their own future managers. They will often assign the client project lead to a developer they are looking at for a future management position. This allows them to get a look at their management skills, and we get a dedicated client lead working hard to make a good impression. Faculty benefit from I4I projects, in that they help them stay current. Being involved in I4I allows continuous exposure to the technologies and techniques currently being used in the business world. Students often point to I4I as the most discussed class during their job interviews and the class that prepared them most for their future employment. Students value the learning experiences, even from the occasional project which "goes awry."

References

1. Cuseo, Joseph B. 1998. "Objectives and Benefits of Senior Year Programs." In The Senior Year Experience: Facilitating Reflection, Integration, Closure and Transition, ed. John N. Gardner, Gretchen Van der Veer, and Associates. San Francisco: Jossey-Bass.
2. Henscheid, Jean M. 2000. Professing the Disciplines: An Analysis of Senior Seminars and Capstone Courses. Columbia, SC: University of South Carolina, National Resource Center for The First Year Experience and Students in Transition.
3. Levine, Arthur. 1998. "A President's Personal and Historical Perspective." In The Senior Year Experience: Facilitating Reflection, Integration, Closure and Transition, ed. John N. Gardner, Gretchen Van der Veer, and Associates. San Francisco: Jossey-Bass.
4. Journal of Information Technology Education Volume 1 No. 2, 2002 Experiences in Developing and Implementing a Capstone Course in Information Technology Management Daniel Brandon, James Pruett, and Jim Wade Christian Brothers University, Memphis, TN, USA