Developing a Directed Information Systems Capstone to Enhance Cloud Competencies

Lionel Mew
lmew@richmond.edu
School of Professional and Continuing Studies
University of Richmond
Richmond, VA 23173

Abstract

This work discusses transformation of an information systems (IS) capstone course to enhance cloud computing and consulting competencies, and incorporate lessons learned from a previous offering. It is well accepted that capstone course benefits include integration, improved self-efficacy and problem solving competencies, team experience, and incorporation of emerging technologies. The course is targeted to continuing non-traditional IS students at a small national liberal arts university. Lessons learned from the legacy course include changing from traditional to directed delivery model and using emerging cloud technologies. The traditional systems analysis capstone is transformed into a directed analysis of alternatives (AoA) to meet a cloud based requirement, followed by development of a prototype based on an AoA use case. The new course uses a real-world scenario to help students gain relevant workforce skills. The expected outcome is an understanding of cloud computing and its value, problem solving and basic information systems consulting competencies. Most importantly, Students reap the benefits of working on an integrative, real-world project in a team environment. This paper explains how the new course is developed, includes a detailed description of course activities and sequence, and discusses metrics to be used to evaluate the new course.

Keywords: Information Systems Education, Directed Capstone, Cloud Computing, Integrative Experience, Consulting, Non-Traditional Students

1. INTRODUCTION

This paper describes transformation of a capstone course, using a directed model to enhance the student experience, give students practical knowledge, improve their self-efficacy, provide consulting basics and incorporate emerging technologies, using lessons learned from a legacy course. The course is designed for non-traditional students in information systems enrolled in a continuing education program at a national small liberal arts university. Following the first offering of the original course in 2014, it was felt that the course could be improved by incorporating lessons learned from the first offering.

The original traditional capstone course was designed and delivered in to give students a cumulative, real-world experience that would enhance their self-efficacy and confidence as they enter the workforce as information systems practitioners. This course focused on completing a traditional applied systems analysis with a requirements document deliverable, integrating competencies learned throughout their programs. Although the course was successful, it was felt that improvements could be made in several areas. This paper discusses how those improvements have been incorporated, and the course transformed for its next presentation.

This involves four distinct activities, first individually, then as a group. These begin with instructor directed readings, leading to a basic understanding of cloud terms and concepts, and consulting concepts. The first section of the course is assessed through an online test. Students next perform library research on the current state and application of cloud

technology, assessed by writing a short paper on their findings. Finally, students participate in a small group project conducting an analysis of alternatives using a real-world scenario for a notional customer, followed by development of a prototype system.

Target Audience

There is no universal definition of a non-traditional student. However, demographic information gives perspective to the typical student at the School of Professional and Continuing Studies (SPCS). The average student age is 37. Although the majority of students have traditionally been men, the number of women in the program is slowly increasing, with women accounting for 46% of enrollments in the current semester. Experience levels and goals of women are similar to those of the male students.

Eighty-one percent of students are part-time. Both part-time and fulltime students are working on either Bachelor of Science in Professional Studies degrees with a major in Information Technology Management or Information Security, or a post-bachelor Certificate in Applied Studies in Information Systems or Information Security. Student experience varies, with some having associate's degrees or at least some community college work, and have immediately transferred to SPCS with a desire to complete their bachelor's degree. Others have been in the workforce for some time, and need a degree for promotion. Still others are trying to break into the information systems field, often with significant life experience and success in other fields.

The result is that there is wide variance in student understanding, experience and ability. All of the major core courses are classroom courses, although some are offered in hybrid format. There are currently no completely online information systems courses, although some non-major courses may be taken online. Most of the students live in the local metropolitan area, and most stay in the area after they graduate. Courses are generally capped at 15 students, allowing significant individual attention and interaction with instructors. The capstone course is a four credit hour course meeting weekly in traditional format.

This demographically diverse student population presents numerous opportunities as well as challenges. Many of these are well known and well documented elsewhere, such as the benefits of experience and maturity, and the challenges of family and work obligations. The capstone experience is arguably more important to this student population – where the traditional student students continue to mature and learn to think critically during their degree programs, it is expected that the continuing students in this program focus more on professional competencies, with the focus for instructors to help students grow professionally.

2. LITERATURE REVIEW

Capstone Value

The literature strongly informs that capstone projects add value to MIS programs. Dunlap (2005) suggests that introducing students to problem-based learning through capstones increases their self-efficacy at problem solving in the real world. Increasing self-efficacy facilitates participants in attempting to solve problems they may otherwise hot have attempted. Others (Brandon, Pruitt & Wade, 2002; Gupta & Wachter, 1998; Lesko, 2009) suggest that capstone courses help students acquire practical knowledge and integrate core competencies in the information systems curriculum.

Cameron (2008) argues that focusing on the enterprise, and the integrative nature of the capstone, prepare IT professionals for today's workplace. Novitzki (1998) discusses the development of an integrating capstone course and the challenges associated with the initial course delivery. Novitzki finds that capstone experiences add value to academic programs, and provide students with real world experience

Capstone courses improve student confidence. A 2005 study (Dunlap) suggests that capstone projects introduce students to problem-based learning, and increase their problem solving self-efficacy in realistic environments. This increased self-efficacy facilitates participant attempts to solve problems they would not have otherwise attempted.

Pedagogical Delivery

There is a significant body of literature discussing various pedagogical delivery methods for capstone courses. A 2004 study (Lynch, Goold & Blain) discusses student preferences regarding how IT capstone courses are delivered. The authors of that study suggest that the selected delivery method affects the amount of control instructors have over course

conduct, based on the pedagogy of the teaching model.

Four models are discussed in the 2004 study, consisting of industry sponsored, studio, traditional and directed approaches. The industry sponsored model involves students playing the role of junior employees at the sponsoring enterprise, with tasks assigned during the course dependent on enterprise needs. In the studio model, students collaborate with experts and mentors. In the traditional model, students collaborate, in teams, on internal or external projects, with a low level of interaction with faculty. Finally, in the directed model, students work with a technical and a managerial faculty member, on a clearly defined set of deliverables. In their study of 196 students from three institutions, studio, traditional and directed models were examined. The most significant finding is that students much prefer well-defined deliverables.

Gupta & Wachter (1998) describe delivery methods that may be used for a capstone course. These include targeted assignments, Situation Analysis Reports (SAR) and case studies. The targeted assignments are designed to lead students to consider the scenarios used in the course, with outcomes defined in advance. Case studies help students understand the impact of technology on the enterprise. The SARs help students identify specific business problems and define how technology may be leveraged to solve the problems.

In a 2014 paper, Pollicia, Ding and Yang describe a capstone course for information security students. The paper describes a capstone course where students are provided with directed readings to develop a foundation for the context of the project. They are then directed to perform library research to further develop their understanding and context. Finally, they conduct an experiment and write a report on their findings.

Emerging Technologies

The literature supports the importance of incorporating emerging technologies into the capstone. Gupta & Wachter (1998) believe that a capstone course could and should be used to integrate emerging technologies. Another paper (Kumar, 2006) discusses strategies to include emerging technologies in capstone courses, maintaining relevance. Kumar suggests that if new technologies are not incorporated, students are less competitive on the job market. He suggests that while it may be difficult to quickly change curricula, rapid changes may be made to individual courses, and strategies to achieve this result are suggested.

One of the most significant emerging technologies currently changing the information systems field is cloud computing. The National Institute of Standards and Technology (NIST) definition of cloud computing is "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (Mell & Grance, 2011, p.3) This definition is the most cited, and is accepted throughout industry.

NIST amplifies their definition in terms of characteristics, three service and five deployment models. Service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The five deployment models include private, hybrid, community and public models. Private clouds are those owned by a single organization. Public clouds provide services to multiple enterprises using the same shared infrastructure. Hybrid clouds, partially private and partially public, are often used to leverage the security of the private cloud with the scalability and other advantages provided by the public cloud. Community clouds are defined as those used by a group of users who share similar interests, and where similar needs are addressed by sharing similar infrastructure in the cloud solution.

3. ORIGINAL COURSE

Students enrolling in the original course were required to obtain departmental permission to register for verification that they had completed relevant coursework or had equivalent work experience. This was important for undergraduate certificate students, as those students often had significant experience in the field, but had taken few academic courses.

The first class meeting discussed course syllabus, goals and objectives, and introduced students to the environment of working as a consultant. Students groups were assigned by the instructor, and students were given time to get to know their teammates, as well as discuss proposed projects. Students were required to

find their own projects, although the instructor had backup projects should they be unable to find projects on their own.

After a few weeks, it was quickly apparent the students were unable to find projects of sufficient scope and rigor to meet course requirements. The instructor then assigned two real-world requirements analysis projects, found within the school, which would meet the course requirements.

A detailed description of the outline for a requirements document was provided to students. This outline followed a traditional systems analysis development methodology, with interim deliverables throughout the semester. Each interim deliverable was intended to be incorporated into the final presentation and report. Early in the semester, and even with the instructor assigned projects, groups began to universally miss deliverable targets, and had a difficult time completing the tasks required. Students indicated that they were overwhelmed by the complexity of the projects.

With extended deadlines and prompting by the instructor, each group was finally able to complete and present their final reports during the last class. After considering the outcome and lessons learned from the first course offering, it was decided to revise the course to improve the student experience, make the course less daunting, and to incorporate the emerging cloud technologies.

4. REVISED ELEMENTS

Elements to be Incorporated

As the revised course was developed, there were several elements desired to be incorporated into the course, largely due to the experience of presenting the original course. Prerequisites of a project management or systems analysis course have since been added, as some of the students had no understanding of the analysis process, and had no experience working in groups.

The subject of the course project should be provided to students, rather than asking them to choose their own projects. A directed delivery model should be used. The course should be team taught, with one instructor serving as the client and subject matter expert for the course projects, and the other as a consultant and mentor to the teams. Different delivery methods should be used to enable additional modes of instruction. A cloud computing scenario should be used to help students develop competencies in this emerging technology. The traditional systems analysis should be replaced by an analysis of alternatives for a cloud solution to keep the course relevant in development of current systems.

Project Selection

The original offering of the course required students to find their own real-world enterprise to use for their course project. When the author previously taught master's degree students, they were expected to find their own enterprises. Although backup projects were available, those projects were rarely required. In the original offering of this course, the previously used master's syllabus was used, with changes only to the rigor to accommodate undergraduate students. However, students were unable to find viable projects after several weeks, and the instructor had to provide projects for each group.

There are several reasons why students experienced difficulty in finding sufficiently rigorous projects. The master's degree students had much more experience and a larger professional network, helping them find projects more easily. Experience also gave them confidence to work on finding a suitable project. Experience also allowed them to put the project in context, helping them to recognize potential enterprises to be clients. On the other hand, the undergraduate students were overwhelmed by the very task of finding a project. Although many of these students were employed in the field, they often had entry level positions not helpful in finding suitable projects. Many of the undergraduate students had jobs ranging from help desk to call center to desktop support roles, positions not conducive to finding potential clients. Although many projects in the local area from non-profit organizations, businesses and government agencies were available, the students were unable to develop the necessary relationships to secure customers on their own. For those reasons, and to better control the course, it was decided to move the capstone to a directed approach.

Delivery Method

Because of the move to instructor selection of the course topic, as well as the experience delivering the original course using a traditional

delivery model, it was decided to change the pedagogical delivery to a directed model.

In the directed model as described by Lynch, Goold & Blain (2004), students work with technical and managerial faculty members to complete well defined deliverables. That work finds that a move to a directed model is advantageous for undergraduate students, as the undergraduates prefer more structure in their assignments.

Team Teaching
Since the new course uses a directed delivery method, it was decided to team teach the course with two instructors. Use of two instructors involves one instructor acting as the client, while the other instructor provides mentoring for each team's analysis of alternatives. This separation of duties is anticipated to result in added realism for the students, since the scenario requires them to interact with and extract requirements from the client instructor as they would with a real-world customer. This also allows the instructors to drive the results of the analysis of alternatives, yielding more control over the learning outcomes.

Other Delivery Methods
The use of other modes of delivery is be used. Students in the initial offering always enjoyed exercises and assignments that allowed them to participate in diverse and interesting learning activities. The hands on aspect of these exercises was attractive to students. Gupta and Wachter (1998) suggest pedagogical methods that could be used in capstone courses. Some of these include targeted assignments, Situation Analysis Reports and case studies. These additional methods are expected add value to the student experience, and they should be included in the revised course.

Incorporation of Cloud Computing
Prior to starting development of the new capstone course, a strategic decision was made to implement a cloud paradigm for pedagogical delivery of course content at the institution. The decision was based on numerous advantages anticipated to be realized from the switch. First, at a small institution with limited class sizes, local hosting of applications necessary to conduct information systems courses such as application development, computer networking, IT security, database development and systems analysis is outside the financial sustainment model, so cloud computing would have to implemented at the school. Developing cloud competencies is also becoming a field necessity, and is important to student professional development.

A key requirement of a capstone is that it is relevant to the needs of industry and that of prospective employers. The original syllabus was based on traditional system development, with the typical systems analysis, interface, database, reliability, etc. sections in the requirements document. The actual solutions submitted, however, were all cloud based. The original course requirements could not be completed, as they were designed for a traditional client-server development project. Consequently, was decided the revised course should incorporate cloud competencies.

Analysis, Integration and Relevance
An important attribute of a capstone course is how well the course integrates the student competencies learned throughout the program (Lesko, 2009). This integration helps students use core competencies acquired during their program in a way that improves their confidence and ability. The experience should prepare them to conduct similar analyses upon employment. It is important to ensure that the integration of core competencies is an important part of the planning during successive course offerings.

One of the key requirements for a capstone course is that it remains relevant to the needs of industry and prospective employers. The analysis for the course project was changed from a traditional requirements analysis to an analysis of alternatives based on a client requirement for a cloud solution, giving students an integrating experience, while remaining relevant by continuing to help them develop a cloud competence.

Group Size
The number of students in each group was five in the original offering, anticipating the traditional systems analysis and associated work. Since the new offering would be an analysis of alternatives (AoA) for a cloud based solution, the number of students per group is changed to three. This is consistent with the similar IT security capstone course used for inspiration (Pollacia, Ding & Yang; 2014).

5. THE COURSE

This section describes how the proposed course will be conducted. It is anticipated that the course will be offered during the Spring 2016

semester. Although students taking the course will likely have completed most of the other program required courses, the only prerequisites are the project management or systems analysis courses. Consequently, there is anticipated to be some variance in the knowledge of individual students. It is hoped that the students in each group will have different individual competencies and contribute to their teammate's experiences.

The sequence of the course is as follows:

1. Students develop a basic understanding of consulting topics through handouts and discussions.
2. Students develop a basic understanding of cloud concepts by reading materials provided by the instructors and through class discussions.

   [Assess students on (1) and (2) through online test]
3. Discover new cloud capabilities and functionality through library research.

   [Assess students on (3) through a short (1250 word) paper]
4. Students interact with and analyze customer requirements for a cloud based system.
5. Students develop and present a plan to conduct an analysis of alternatives.
6. Students develop an understanding of cloud providers by conducting online research and viewing and conducting demonstrations.
7. Students collect information, analyze and develop AoA findings and recommendations.
8. Students finalize recommendations, prepare and present a final report.
9. Students create a prototype system using a use case from the AoA.

   [Assess students on final report and presentation, and prototype demonstration]

Understand Consulting Topics
There is a consulting component to the course, where students will be provided with fundamental consulting concepts. Consulting topics will be discussed, and handouts are provided on consulting topics. Students will be exposed to all aspects of working as an individual consultant.

Gain Basic Knowledge
As juniors and seniors who have completed the bulk of their major coursework, most of the students taking the course have some knowledge of cloud computing. Many have taken cloud based networking courses or virtualization courses as electives. However, there is variance among student knowledge levels due to the fact that the only hard prerequisites are completion of an IT project management course or a systems analysis course. Therefore, students will first gain a fundamental understanding of cloud concepts by reading articles provided by instructors. The content of the papers is further discussed in class, and students are assessed through an online test addressing basic consulting and cloud concepts.

Understand New and Emerging Cloud Developments
Since cloud computing is an emerging technology, cloud paradigms, capabilities and functionality are constantly changing. Students discover the latest information on cloud functionality through library research. Since the school has a dedicated reference librarian, a library seminar is first presented to refresh student library skills. Information pertinent to this specific topic is provided by the librarian. The librarian also develops a library course page with links to content applicable to this particular course.

The assignment is for students to individually find five relevant articles on improved cloud capabilities and write a short 1250 word paper, which will be assessed using an argument paper rubric. Their findings will be combined with their teammate's findings for inclusion in the background section of their projects.

Examine Customer Requirements
Students will meet with an instructor who will play the part of a client throughout the course. The customer requirement is to choose a major cloud provider to support the information systems courses for the school. Examples include a database course, where a database and interface must be available, a networking course where virtual servers and network components are available for configuration, a development course, where coding applications, databases, etc. are available virtually, a systems analysis course with case tools and database

available, etc. Use cases will be developed for each scenario. Students will meet with the client throughout the course to ferret requirements out and ask questions regarding necessary functionality in the cloud solution. Students will be assessed through grading of their deliverables throughout the course.

Develop and Present a Plan
After meeting with the client and capturing requirements for the proposed system, student groups will develop and present a plan for the analysis of alternatives. The plan will be presented to the client (in class) for approval, allowing students to articulate what they plan to do in their analysis, get customer feedback, and allow instructors to redirect their efforts if necessary. They will learn by viewing presentations by other groups, incorporating good ideas into their plans. They will be assessed by grading of their plans and presentations.

Understand Capabilities of Cloud Providers
Students will be exposed to the capabilities of major cloud providers through in-class demonstrations of cloud functionality using three major cloud providers. They will also begin to obtain information on capabilities of these providers by conducting online research on these providers. They will be provided with student accounts and develop prototype applications on cloud provider sites. As they develop an understanding of the capabilities of these providers, students will begin to glean information pertinent to their projects, and begin to develop pros and cons of each provider relative to the customer requirements. They will be assessed by their performance on course deliverables.

Develop Findings and Recommendations
As they continue to better understand the various cloud paradigms and collect information, students will analyze the information with regard to the customer requirements, and begin to develop findings and recommendations. Students will continue to work closely with their customer, and continue to be advised by their consulting faculty member. They are assessed through grading of their Midterm Progress Briefing.

Final Report and Prototype
Once all relevant information has been collected and analyzed, students will prepare and present a final report with findings and recommendations using a template provided by the instructors, and demonstrate their prototypes. This report and demonstration will be the culmination of their semester project, and includes all information captured during the course. They will be assessed by grading of their reports, presentations and demonstration, and through peer evaluations.

6. FUTURE RESEARCH

Once the proposed course has been offered, feedback and lessons will be evaluated, and metrics will be used to evaluate the success of the proposed offering. Student evaluations will be used to determine whether students felt this course added value to their development and professional knowledge. Multivariate regression analysis will be used to explain the variance, and Structured Equation Modeling will be used to discover latent variables.

Another suggested metric is student self-efficacy. A survey instrument will be used to collect self-reported information on perceived changes in self-efficacy on core competencies, using a standard self-efficacy scale, modified to reflect competencies identified in the course objectives.

Student acquisition of cloud competencies will be measured using survey data on cloud self-efficacy, and adoption of could competencies using a technology acceptance model.

7. CONCLUSION

This work consists of developing a revised capstone course for non-traditional undergraduate students comprising a requirement driven analysis of alternatives for a cloud based system. The revised course differs from the legacy traditional course by including the following components and value:

- The course project subject will be provided to students, enabling them to immediately start on their projects, and allowing the instructors to exert control over course presentation, content, conduct and outcome.
- A directed pedagogical delivery model will be used, enabling students to apply their efforts towards well-defined tasks controlled by the instructors, yielding planned and controlled results.
- The course will be team taught, with two instructors in client and advisor roles.

This separation of duties makes the scenario more realistic for students, since instructors do not have to switch roles, confusing the students.

- Other delivery methods will be used to add additional modes of instruction, making the course more interesting, and the instruction more effective. Such methods as targeted assignments and
- a
- ch major cloud provider's ability to meet customer requirements.
- An AoA to meet client requirements will be conducted, enabling students to focus on a real-world scenario where effectiveness, suitability and cost are considered, and a recommendation will be made.
- Students will construct a prototype using one of the use cases developed during the AoA.

The end result will be an improved course that effectively integrates student competencies, provides them with a confidence building experience, and improves their knowledge of cloud computing.

The success of the new course will be measured by examining student feedback and evaluation data, student self-efficacy and technology acceptance metrics.

8. REFERENCES

Brandon, D., Pruett, J., & Wade, J. (2002). Experiences in developing and implementing a capstone course in information technology management. *Journal of Information Technology Education: Research*, *1*(1), 91-102.

Cameron, B. H. (2008, April). Enterprise systems education: new directions & challenges for the future. In *Proceedings of the 2008 ACM SIGMIS CPR conference on Computer personnel doctoral consortium and research* (pp. 119-126). ACM.

Dunlap, J. C. (2005). Problem-based learning and self-efficacy: How a capstone course in-class exercises add value by giving the students hands on experiences with clearly defined outcomes.

- A requirement for a cloud solution will be used for the course project, developing student cloud competencies, and making students consider the advantages and disadvantages of e

prepares students for a profession. *Educational Technology Research and Development*, 53(1), 65-83.

Gupta, J. N. D., & Wachter, R. M. (1998). A capstone course in the information systems curriculum. *International Journal of Information Management*, 18(6), 427-441.

Kumar, A. (2006). Strategies to enhance student learning in a capstone MIS course. *Issues in Informing Science and Information Technology*, 3, 327-332.

Lesko Jr, C. J. (2009, October). Building a framework for the senior capstone experience in an information computer technology program. In *Proceedings of the 10th ACM conference on SIG-information technology education* (pp. 245-251). ACM.

Lynch, K., Goold, A., & Blain, J. (2004). Students' pedagogical preferences in the delivery of IT capstone courses. Issues in Informing Science and Information Technology, 1, 431-442.

Mell, P., & Grance, T. (2011). The NIST Definition of Cloud Computing.[Online] Available at: http://csrc. nist. gov/publications/nistpubs/800-145. SP800-145. pdf.

Novitzki, J. E. (2001). Critical issues in the administration of an integrating capstone course. Proceedings Informing Science and Information Technology Education 2001, 372-378.

Pollacia, L., Ding, Y. Z., & Yang, S. (2014). Why Phishing Works: Project for an Information Security Capstone Course. In Proceedings of the Information Systems Educators Conference ISSN (Vol. 2167, p. 1435).