Creating Synergy between Undergraduate Senior Computing Research and Applied Capstone Courses

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Abstract – This study presents a look at the synergy created between two undergraduate computing courses in the Computing and Technology Department at Cameron University – MIS 4473 Current Topics in IT, and IT 4444 IT Capstone. The focus of MIS 4473 was student group case study research, utilizing: (a) the success of Computing and Technology faculty academic publications, (b) guidelines from an international computing conference, (c) an iterative writing and editing process, and (d) a blind student peer review process. The focus of IT 4444 was applied multidiscipline systems software development in a service learning capacity for real clients. Students in MIS 4473 conducted case study research on concurrent IT 4444 capstone projects and presented findings at the end of the semester, thereby simulating the computing conference experience. The authors discuss the necessity of such synergy in relation to improved student research skills and service learning reflection.

Keywords: Undergraduate Computing Research, Capstone, Software Development, Reflection, Synergy

1 Introduction

For a number of years, the Computing and Technology Department at Cameron University has offered the senior undergraduate course IT 4444 IT Capstone. In a service learning capacity, students from multiple disciplines of Information Technology (IT), Computer Science (CS), Multimedia (MM), and English (ENG) work together in teams to develop actual systems software for real clients. Clients benefit in gaining software for their needs and in saving hundreds of thousands of dollars not being paid to industry developers. Students benefit in gaining real software development experience and a letter of recommendation. Past clients have included, city government IT departments, city government police departments, hospitals, and others. It is common for IT 4444 students to be hired in desirable, high-paid IT positions, specifically because of their capstone experiences [1, 2]. However, Cameron University administrators overseeing campus service learning expressed a concern that a stronger reflection component may be needed in the capstone course. This has been difficult to accomplish in IT 4444, due to the rigor, scope, and scheduling of actual systems software development.

Separately, and more recently, the Computing and Technology faculty decided to add a dedicated required computing research course to the IT core curriculum. This was in accordance with the Association for Computing Machinery (ACM) IT 2008 curriculum guidelines [3] “to integrate case studies into IT courses in a way that emphasizes the importance of understanding the application domain.” Initially, a temporary seminar course, MIS 4473 Current Topics in IT, was created for such a purpose. When developing this course, the instructor determined that students would benefit by conducting research according to the guidelines of an international computing conference. This was partially based on Computing and Technology faculty success in academic publication of case studies on the IT 4444 capstone class projects [1, 2]. After some research and analysis on the subject, the MIS 4473 instructor believed that students would also benefit by conducting similar group case study research on their capstone experiences, but from a student perspective. It was discovered later that MIS 4473 would also supplement the needed reflection component of the capstone course.
The remainder of this study will illustrate how synergy is created by partnership of the MIS 4473 research and IT 4444 capstone courses, from the research perspective.

2 Brief Literature Review

There appears to be a large number of studies in the literature focusing on undergraduate computer research separate from, and not specifically related to, applied capstone systems software development projects. However, what is important to this current study is the focus on literature regarding a possible relation of synergy between both undergraduate computing research and application.

Schneider [4] discussed a required 1-credit CS undergraduate senior capstone research seminar to simulate a computing conference experience. The seminar was taken during both semesters of the senior year. Students had some choice in selecting subject matter which was related to previous CS coursework. Activities included lectures on presenting scientific data and conducting research, Mathematica demonstrations, talks from the campus Writing Center director, and presentation techniques from a Communication Studies professor. There were also individual and group meetings with the seminar instructor used as progress checkpoints. It is important to note that the capstone mentioned here was the research course, as opposed to applied software development.

Jonas [5] described an undergraduate Computer Information Systems (CIS) capstone experience where pure research was being conducted on automated speech recognition technologies. The course had been offered each spring semester for four years as of the publishing of the study. Each year, the research was continually built upon utilizing the previous year's findings. Student grades were based upon 15% individual work, 35% group work (including a proposal and final report), and 50% anonymous and extensive student peer reviews. Possible application of research was mentioned in future plans, but not realized yet. In this study, the capstone mentioned here was the research course, as opposed to applied software development.

Sun and Decker [6] discussed a dual undergraduate capstone model. One path would be structured toward conducting research for students who intend to pursue graduate studies. Students involved in this path work toward individual research mentored by faculty, with the mentor approving the research area. The other path would be structured toward software application development for students who intend to work in industry. In the second path, real non-profit clients are selected (for societal benefit). Also, it is more common for group work to transpire in the second path. This model is designed to be suitable for both CS and CIS students.

Khmelevsky [7] shared experiences of the CS department undergraduate research and teaching strategies at Massachusetts Institute of Technology. Students were able to select work on applied industry projects in multiple courses. In incorporating research into one of those courses, the purpose was to develop student academic publications. While several strategies were mentioned, there was one that stood out the most in relation to the current study - “Students need additional time to publish a research paper. In a project course students can finish an experimental part of the research project as well as an initial research, but they need extra time for research paper writing.”

In summary, the author found the following undergraduate computing examples relating research and capstone in the literature: (a) the capstone as a research course to introduce students to a computing conference type of experience, (b) a capstone experience as a pure research project that documented processes for continued use in future course iteration with potential application, (c) a dual capstone experience that allowed students to choose between a research path in pursuit of attending graduate school and a path developing applications in pursuit of working in industry, and (d) a combined course that contained both a research component and an application development component, with an emphasis that more time was needed for students to conduct research.

3 Methodology

Based upon faculty perception of student needs and the literature, the instructor of MIS 4473 decided the best course of action would be to pattern research after the computing conference experience. The Cameron Computing and Technology faculty had experienced significant success in publishing and presenting at computing conferences. It was common for the faculty to publish case studies related to the IT 4444 capstone experience, from a faculty perspective. The MIS 4473 instructor believed students would receive similar benefit in conducting research over the capstone course experience, from a student perspective.

3.1 Initial Meetings

Students were informed of the purpose of MIS 4473, which was conducting research based on their concurrent IT 4444 capstone course. It was explained that IT 4444 would provide them with an applied systems software development experience, while MIS 4473 would provide them with a
reflective research component. Each course would synergistically reinforce one another. IT 4444 would provide them with capstone material to conduct case study research, while MIS 4473 would help them to more fully comprehend what transpired in the capstone course.

MIS 4473 students were only required to purchase one item for the class, that being an ACM student membership with the Digital Library. The purpose was twofold. Students would have access to a vast library of computing research materials. Also, being an ACM member could be helpful in their futures as computing professionals upon graduation [8].

It has been a common experience for the Computing and Technology faculty to contribute as coauthors on published papers. To simulate this experience, MIS 4473 students were required to work in groups of no less than three and no more than five. The students were allowed the opportunity to select their own coauthors. In future assignments, students were also required to provide a detailed breakdown of each student coauthor’s contribution.

3.2 Assignment Parameters

The WorldComp computing conference publishing guidelines were chosen as a pattern for students to follow. WorldComp is a major international computing conference with several hundred papers published and presented annually in multiple computing disciplines [9]. The MIS 4473 instructor lectured over the information found at the conference website. Students were provided with the conference website links and were required to write a detailed report on what WorldComp was about and how prospective authors engage in the publishing/presentation process. The reports were submitted through a program that checks for plagiarism, as students were required to write using their own words.

Students were also provided with faculty examples of capstone-related papers that were published in previous WorldComp conferences. The students were able to use these papers as example templates. However, the students were also reminded that these papers were written from a faculty perspective, while the students would be writing from their own perspective. A formatting template from WorldComp was also supplied to the students.

At this point, students were required to develop the beginnings of a paper title and abstract, based on their Capstone projects. It is important to mention again here that the IT 4444 capstone course had multi-discipline teams of IT, CS, MM, and ENG students, working in teams on actual systems software development for real clients. This included the development of an HTML/CSS frontend, PHP middleware, a MySQL backend database, and the use of CASE tools. Therefore, the student research groups in MIS 4473 would be focusing on different areas, depending on their involvement in IT 4444. For example, some student groups mainly focused on cyber security issues, while others focused on database programming. Student groups were also required to visit with the instructor in his office for editing and content critiques before they were allowed to submit their work. All submitted work was checked by the plagiarism program.

Several class sessions were set aside for all students to visit the Cameron University Writing Center and Library. Writing and research presentations were provided to students by the directors at both of these locations. Students were also required in future iterations of their research to utilize these facilities, as well as the ACM Digital Library.

The next step in the process was instructor graded feedback provided to each authoring group, followed by a class peer reviewed critique of the submitted title and abstract. The instructor first provided feedback upon submission. After that, all identifying information was blacked out to provide the simulation of blind peer review. The title and abstract were taken into class and projected on a screen. Then the students were collectively asked by the instructor to critique what they read, followed by instructor critique based upon the prior feedback.

Multiple iterations of writing and instructor/student peer review were performed in a similar manner. Written work was submitted to the instructor at approximately 50%, 75%, and 100% completion intervals, to coincide with work as completed in the applied IT 4444 capstone class. However, during each of these iterations, student groups were required to visit the Writing Center for critiques and editing. Afterword, they had to visit with the instructor for additional critiques and suggestions. This was again followed by graded instructor feedback. Then lastly, blind peer review (names being blacked out) took place in which the students and instructor provided critiques of the written materials projected on a screen in class.

Several class periods were also allowed for students to meet and work in their groups, as these periods provided the most efficient times for such collaboration.

Figure 1 shows two typical assignment instruction examples...
Required Study and Preparation: Given 1/15/2015

- Read through the information found at…
  - http://world-comp.org/
  - http://www.worldacademyofscience.org/worldcomp14/ws/authors/typing_instructions
- Choose your group members. Each group must have at least 3, and no more than 5, members.

Assignment 1: Given 1/14/2015, Due 1/28/2015 by 11pm CST

- **Exercise 1, Group:** Write a single-space, full 2-page, 12-point font, 1” margins, report on what the Worldcomp conference is about and how prospective authors engage in the process. Spelling and grammar count. Every group member must participate.

- **Exercise 2, Group:** Come up with a topic related to your major concentration area to write about. Keep in mind that the topic should have some interest and somehow present new information (it is recommended to use the Database or IT Capstone projects for this purpose). Write a title and abstract about that topic using the format from the supplied Worldcomp template and the faculty papers under Course Documents in Blackboard. Spelling and grammar count. The topic must be approved by the instructor approximately one week prior to submission. Points will be deducted without this approval. If deemed unsuitable by the instructor, either a revision or another topic will have to be completed. Groups must make an appointment to visit the instructor for this purpose.

- **Exercise 3, Group:** In addition, supply the name of each group member and detailed documentation of each group member’s contribution.

Submit your document (in Word format) to the Assignment 1 submission link by the due dates (found in your MIS 4473 Blackboard course under Assignments). It is only necessary for one group member to make this submission. Also, group members will need to write using their own words, as the work will be submitted through SafeAssign. Anything beyond a 20% match may result in severe loss of points.

Required Study: Given 1/28/2015

- Ultimately, the final paper will need to be about 7 pages including all figures, tables, and references, set up according to the WorldComp conference guidelines, and with a minimum of 6 references from either .edu, .mil, .gov sources, or from published books. I have placed two papers in Course Documents that were published by our faculty at previous WorldComp conferences to give examples, along with a formatting template.

- Begin to explore the ACM website (http://www.acm.org) after you purchase your student membership with the Digital Library. There are many resources that will be of benefit to students now in a research capacity, and later in an industry capacity.

- I will arrange some class meetings for students to watch presentations given at the Academic Writing Center, and at the Library. Stay tuned for announcements on meeting dates.

Assignment 2: Given 1/28/2015, Due 2/25/2015 by 11pm CST

- **Exercise 1, Group: Paper Draft 1:** Using the given examples as a guide, begin putting your paper together. This will be a work in progress, approximately 50% complete, but there should also be a skeletal outline including parts that can’t be completed until later. What should be more complete are areas that have taken place up to the point of the due date. Spelling and grammar count. It will be required from this point forward for each group to take their paper to the Academic Writing Center, to receive proofing before submission. It will also be required that each group will visit with me in my office, supplying documentation that the Academic Writing Center helped with proofing. I will also proof the work before submission. If any of these steps are omitted, students will receive zero credit for this assignment. I will allow several class periods to be used for groups to visit me in my office as necessary. I suggest students take advantage of this time.

- **Exercise 2, Group:** In addition, supply the name of each group member and detailed documentation of each group member’s contribution.

Submit your document (in Word format) to the Assignment 2 submission link by the due dates (found in your MIS 4473 Blackboard course under Assignments). It is only necessary for one group member to make this submission. Also, group members will need to write using their own words, as the work will be submitted through SafeAssign. Anything beyond a 20% match may result in severe loss of points.

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**Figure 1. Typical Assignment Instruction Examples**
3.3 Class Presentation

The final project for MIS 4473 consisted of each group presenting their findings to the class, utilizing presentation slides or other materials as necessary. As previously experienced by Computing and Technology faculty, this is exactly what transpires when a faculty paper is presented at a computing conference.

This presentation was also attended by faculty involved in teaching the IT 4444 capstone class. At the end of each presentation, questions were asked by the students, the MIS 4473 instructor, and the IT 4444 faculty. The completed papers, presentation, and question/answer period provided additional validation of utilizing the student reflection component as a supplement to the applied capstone class.

4 Student Perceptions

At Cameron University, students are allowed to provide anonymous comments on a standardized teacher evaluation survey each semester. At the end of the first offering of MIS 4473, there were two student comments relating to the research component…

- “The instructor was very helpful during the class. Although, the class seemed like something I could do on my own, not needing to have a structured class. I like how the instructor puts the responsibility on the student, which I enjoy…helps me to learn more.”
- “I am very glad the class was changed to this research class. I just wish the class research paper was the standard for all campus research papers. This class has given me enhanced knowledge for writing and research. I only wish I could take another class like this. I believe there should be more classes that link each other like this one did with my capstone.”

5 Discussion

The MIS 4473 instructor noticed several problematic areas students commonly encountered during the research and writing process…

- **Tense and Person:** Students would commonly mix tense and write in first or second person. The MIS 4473 instructor required students to write in past tense and third person. They had to be reminded of this on multiple occasions.
- **Long Sentences:** It was common for students to write very long sentences. Students were regularly reminded that if a sentence is read aloud, there should be natural breathing points. If one has to gasp for air, a sentence is probably too long.
- **Multiple Writers:** Students divided the work in writing sections of their papers, which is appropriate for group research. However, it was apparent in the editing process that some would not read each other’s sections. The writing styles would not flow well in that case. Also, abbreviated terms were set up in an earlier section, and not used later in the paper. For example, *Information Technology (IT)* had been used early on, but *IT* was not used again. Instead, *Information Technology* was used in all later sections.
- **Native Language:** At Cameron University, a large portion of the student population speaks ENG as a second language. However, the MIS 4473 instructor would require proper ENG grammar, as it is a common language used in academic publishing. There are general patterns of writing that indicate when an author is not a native ENG speaker.
- **Citations-References:** It was common for students to express suppositions without supplying proper citations and references to support their claims. Students had to be reminded that they would not be considered experts in the field at this stage of their academic career, and that opinions alone would not be considered worthy of academic publication.
- **Procrastination:** As mentioned before, student groups had to submit successive paper iterations to the Writing Center, as well as visit with the instructor for editing and critique purposes. Several groups had a tendency to wait until a few days before the submission due date to make the required visits. In these cases, the end submissions tended to contain more of the problems mentioned above.
- **Comfort Zone:** During the MIS 4473 blind peer-review process, students were required to openly critique the group papers in class. It was common for students whose writing was critiqued to display some discomfort. In general, nobody likes to have errors critically analyzed and pointed out.

The MIS 4473 instructor believed it important for students to regularly visit the Writing Center, and separately visit the instructor, for editing and critique purposes before submitting work. Multiple iterations of this process helped students to better understand the need to avoid procrastination before paper submission. The instructor equally believed it to be important for students to participate in the class blind peer-
review process. The only way for students to develop a “thick skin” during a review process is to regularly experience valid critique. In writing for conference publication, even highly experienced authors may take offense to critiques that are designed to be helpful.

It is interesting to note that during the blind peer review process in class, students progressively developed a greater sense in understanding the problems mentioned above. They also began to express a certain sense of freedom when offering valid critical review.

6 Conclusion

The MIS 4473 research course has now been offered twice in two years, in conjunction with the IT 4444 capstone course. In both offerings, students were given the opportunity to conduct research over the work performed in the capstone course. In the second MIS 4473 offering, two student groups indicated they would submit their papers to a future WorldComp conference. Overall, students expressed seeing positive benefits, while the faculty noticed improvement in student research skills. Also, a reflection component supplemented the capstone experience. It is the belief of the Computing and Technology faculty that such synergy would prove to be difficult without the use of separate research and applied courses working in tandem. The Computing and Technology Department is currently in the process of converting the temporary seminar course, MIS 4473 Current Topics in IT, to the permanent core course, IT 4013 Research Topics in IT.

7 References


