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Final Project Submission

Excelsior College Bachelor of Science in Information Technology
Competency-Based Capstone Course Plan

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Link to Project Presentation: https://youtu.be/58YfhS2I9Vw

Abstract

In this final submission, we propose a Bachelor of Science in Information Technology (BSIT) capstone course project draft plan. In accordance with the philosophy of the Excelsior College – What you know is more important than where or how you learned it –, the capstone course is the only residency requirement for BSIT students. Due to this reason, BSIT may have limited involvement in students’ education path toward the bachelor degree, and it is therefore crucial for the BSIT program to design and deliver a robust capstone course that helps assess, evaluate, and strengthen students in every aspects of the IT competencies in order to prepare them for the IT workforce. Three key components of the BSIT CBE capstone course – comprehensive outcome assessments, IT projects, and student project reports/ITA portfolios – complement and reinforce each other to ensure that students complete the course have achieved and demonstrated competencies that are required for success in the information technology field.
I. Introduction

Today’s higher-education institutions do not seem to adequately prepare their graduates for the workforce. According to a recent survey conducted by Hart Research Associates, employers generally feel that college graduates are not well prepared across key workplace competencies [1]. Only 37% of the 400 surveyed employers think that recent college graduates are capable of staying current on technologies, and only 24% of them think those graduates are ready to analyze and solve complex problems. While, according to a recent study by Chegg [2], STEM (science, technology, engineering, and math) graduates are better prepared for the workforce than graduates of other fields, still 40% of the 503 hiring managers looking for STEM graduates think that recent graduates are not well prepared to solve problems through experimentation.

Colleges that provide students with opportunities to demonstrate skills and knowledge in real-world contexts increase college graduates’ preparedness for the workforce as well as their hirability [1]. The Hart Research Associates survey results indicate that employers are more likely to consider a job candidate who has participated in capstone projects or internships where they can apply their skills and knowledge to solve real-world problems [1]. Only 59% of their 613 surveyed college students think they are prepared to apply knowledge and skills to real-world. A McGraw-Hill’s study also shows that while 67% of the 1,000 surveyed college students indicated that colleges should provide them with more professional experience to help prepare them for the workforce, only 35% of them think colleges effectively prepare them for a job [3]. This gap between employers’ and graduates’ expectations of how colleges should prepare students for the workforce, and what has been actually offered calls for innovative methods to train and equip students with the set of skills they should master to meet the needs of the workforce.

Competency-based education (CBE) is one such transforming initiative. The Competency-Based Education Network (CBEN) defines CBE as “a flexible way for students to get credit for what they know, build on their knowledge and skill by learning more at their own pace, and earn high quality degrees,
certificates, and other credentials that help them in their lives and careers”[4]. According to the National Postsecondary Education Cooperative [5], competency is “A combination of skills, ability and knowledge needed to perform a specific task” (p. 1), and CBE allows student to progress as they demonstrate mastery of competencies [5]. Different than traditional education models in which student learning is structured around seat time and credit hour, CBE focuses on defining field-specific competencies and its associated training and assessment activities [6]. In other words, CBE depends on measuring student learning and it provides a clearer signal of what graduates know and are able to do [7]. Since in CBE students are advanced as they demonstrate mastery, student learning is thus not only about acquiring the knowledge of a set of facts but also about the application of the knowledge. CBE is therefore able to address the concern about whether college graduates are workplace-prepared.

Excelsior College has long been considered one of the pioneers of CBE. As an educational institution providing CBE for more than four decades, the College has adopted a number of credit-earning methodologies not typically found at other colleges and universities, which includes credit transfer from other institutions, credit from workforce training, credit by examination, credit by portfolio assessment, and credit through online coursework at the College itself. Excelsior College’s founding philosophy – *What you know is more important than where or how you learned it*® – resonates with the essence of CBE. Since its founding, the College has required students to demonstrate, via credible means, that their knowledge and skills are college-level equivalent upon program entry. Excelsior College is directed towards serving populations traditionally under-represented in higher education. It is the College’s mission to “meet students where they are – academically and geographically, offering quality instruction and the assessment of learning.” Through its open enrollment and lack of residency credit requirement, the College removes barriers that exist at many traditional four-year institutions. Further, the ability to complete programs completely online creates access to many where geography and travel limitations might otherwise have prevented the pursuit of a degree.

The proposed capstone course for the Bachelor of Science in Information Technology (BSIT) program represents our continued endeavor to improve our CBE model with the goal of better preparing our
students for the workforce. This is achieved by providing opportunities for students to reflect and integrate their academic and professional achievements and demonstrate their knowledge, skills, and abilities in real-world context. Our current portfolio-based capstone course is composed of learning statements justifying students’ achievements, together with evidences supporting their achievement of learning outcomes. Students of the existing capstone do not have the opportunities of knowledge-application and skill-demonstration, and therefore the effectiveness of this course to prepare our students well to succeed in advancing their careers is questionable. Specifically, our current capstone course is not structured around a set of demonstrable competencies, nor does it require students to apply their knowledge in solving real-world problems. On the contrary, the proposed competency-based capstone will be an integrative experience that allows students to demonstrate the mastery of IT competencies via real-world projects. Students of the proposed capstone course will also have the opportunity to reflect, evaluate, and enhance their IT knowledge and skills. Students will benefit from the capstone course by developing confidence in their requisite information technology skills, as well as in their abilities to solve real-world problems. Excelsior College’s BSIT competency-based capstone course is the culminating experience of a competency-based BSIT program, which will produce qualified and skilled information technology professionals attractive to the workforce. Employers of BSIT graduates will see a seamless connection between graduates’ skills and the skills required to be successful on the job.

In the next section, the structure of the proposed BSIT competency-based capstone will be described in more detail. Figure 1 illustrates the proposed capstone course model.
II. The Excelsior College BS in IT degree program Capstone Course

As can be seen on Figure 1, there are three main components of the proposed CBE capstone course – Comprehensive Outcome Assessment, Capstone Project, and Project Final Report or ITA Portfolio. The purpose of incorporating the three components is to provide students with comprehensive opportunities to demonstrate their competencies in all the 8 IT competency areas (see Appendix A), as well as their achievements of the 13 BSIT Student Outcomes (see Appendix B). This course design also allows course instructors to assess and evaluate student performances in these IT areas. In addition to these course assessment activities, students will reflect on their current capstone progress through journals. These reflection journals and course discussions, will give students an opportunity to get support from their instructors as well as their peer classmates (see Figure 1). This reflection process helps students to evaluate and learn from their own and others’ experiences, and also to develop new ideas to solve
problems at hand [8]. The project presentations and final report/ITA portfolio preparation will further allow them to develop and demonstrate their oral and written communication skills – the key skill set for students to succeed in careers [9, 10]. Through this combination of learning-by-doing and reflection opportunities, students graduating from the capstone course will not only be more able to apply their IT skills in real-world settings, but they will also be more ready to work effectively in team-based environments.

**Comprehensive Outcome Assessment**

The purpose of Comprehensive Outcome Assessment is to assess students' knowledge and skills in the identified IT competency areas. During the three-week period, students are required to complete 8 assignments, one for each of the 8 IT competency areas:

1. Data Communication and Networking
2. Information Management
3. Software Development
4. Cybersecurity
5. Web Development
6. Project Management
7. Enterprise Architecture
8. Human-Computer Interaction

Students will work on assignments to solve real-world problems. Each assignment is designed in a way that allows students to demonstrate the achievement of multiple BSIT student outcomes. Students will be provided with study materials and practice questions, and will also be required to participate in online discussions with peer students on topics pertaining to the competency areas.

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1 For example, a network design assignment assesses students' knowledge and skills of the "Data Communication and Networking" competency area, through which students will demonstrate, and be assessed, their levels of achievements of BSIT Student Outcomes 2, 3, 9 and 11. As another example, a Web design assignment will assesses students' knowledge and skills under the "Web Development" competency area, in which students will demonstrate their levels of achievements of BSIT Student Outcomes 2, 5, 8, 9, and 11.
After submitting assignments, students will receive detailed feedback from the course instructor. The instructor will continue to discuss with each student about his/her answers, identify the key knowledge areas or concepts that the student needs to work on and improve, and work with the student to correct the answers, if needed. Throughout the review and feedback processes with the student, the course instructor evaluates the student’s performance using a rubric to determine whether or not the student has mastered the given IT competency. If a student has adequately demonstrated his/her mastery of a competency, s/he will proceed to the next competency assignment. If, on the other hand, the student does not pass the evaluation, s/he will stay in the same competency area, continue to improve his/her knowledge and skills and work on a different assignment (of the same area). For each competency, students have a maximum of two submission attempts. Students need to receive pass grades for all the IT competency assignments within the first three weeks in order to move forward to the capstone project stage. A student who cannot complete all the competency assignments or who does not pass the evaluations of any of the competency areas after his/her second attempt will not be able to successfully complete the course. The student will have the option to withdraw from the course and take the capstone again. At this point the student may also consider taking advantage of the IT Bootcamp for remediation in the competency areas. (See Figure 1). Figure 2 details the structure of this stage of the capstone course.
Capstone Project

Projects are complex tasks created based on challenging questions or problems, which involve students in design, critical-thinking, problem-solving, decision-making, and investigative activities [11]. As a type of performance-based assessments, projects help students connect knowledge to the context of its application and develop realistic products [7], allowing students to learn through experience. Due to the emphasis on student performance, projects are often adopted by CBE programs as assessments of student mastery [12], and students of projects can experience increased quality of learning [11]. At the stage of capstone project, students are assigned with pre-designed, or self-identified IT projects and work on the projects either in teams or individually. Inspired by CBE, each student project is embedded with multiple IT competencies, which enable students to apply and demonstrate the required IT knowledge and skills as they proceed through the projects. Because CBE relies heavily on assessing what students “can do” [6, 7], this association of student projects with IT competencies, together with...
meticulously developed assessment rubrics, ensure valid assessment-score interpretations and standardized evaluations of student credentials [7].

As an integral part of the student formative assessment process characterizing CBE, timely and meaningful feedback is also key to helping students attain required competency levels [6]. At this capstone course stage, each project team is assigned with one industrial mentor, who is identified based on the IT competencies involved in the selected project. Industrial mentors not only evaluate student performances from an industrial perspective, they also work with course instructors to provide ongoing feedback and guidance and identify learning resources. With industrial experience, industrial mentors know best what knowledge and skills students need to get prepared and can challenge students with current real-world problems. Additionally, students will have the opportunity to participate in online discussion forums to interact with their peer students, through which they ask questions, share past and current experience, vent frustrations, and provide social support. It is through the iterative process among students, industrial mentors, and instructors that a learning community is formed.

Examples of student projects include, but are not limited to:

- Prototyping and developing a professional Web page for a small business.
- Analyzing network traffics, identifying network bottlenecks, and proposing a plan for improving network performance.
- Planning and developing software programs to address real-world problems or industry needs.
- Identifying security breaches in a networked environment and propose solutions

Students will need to discuss with the course instructor to determine the project topic, and depending on the size of student teams, the scope of each student project may vary. Students are required to submit weekly reflection journals reporting their weekly achievements to the course instructor and industrial mentor. The course instructor and industrial mentors will review together student journals to determine student progress and provide feedback.
The final component of the final project portion of the course is the capstone project presentation. One or multiple synchronous student presentation sessions will be held for students to showcase their projects, and all the BSIT instructors and industrial advisory committee members will be invited to attend the presentation sessions. Students will have the opportunity to explain to the attendees the real-world IT problem they were experiencing, the innovative ideas they come up with to address the problem, and the resulting product. Student team projects and their communication skills will be evaluated at this time. By discussing the challenges they faced in the projects and the lesson learned from the project development, receiving feedback from students of different teams and instructors, and discussing further development possibilities, they will enhance their knowledge and understanding of the IT competencies and be better able to manage workplace projects.

**Project Final Report/Research Paper or ITA Portfolio**

This is the last stage of the capstone course, in which students have three options:

1. Students can choose to write a project report documenting the process of project development and discussing the lessons learned.
2. If the project students worked on is a research- or experiment-based one, they have the option to write a research article based on the completed project. A research paper published in journals or conferences will be a key evidence of student achievement in the IT field.
3. Students can develop an Integrated Technology Assessment (ITA) portfolio, which contains learning statements justifying their achievement of the 13 BSIT student outcomes. Students are required to collect professional or academic evidences to support their learning statements in this option.

**IT Bootcamp**

Students may elect to enroll in the optional non-credit IT Bootcamp either before enrolling in the capstone course or after an unsuccessful attempt in the capstone course. This will be a self-paced
bootcamp that allows students to select and enroll in IT competency modules that will provide review of material related to each competency area and short assessments evaluated by an instructor. The bootcamp is completely self-paced and students will be able to choose the IT areas in which they need further review before attempting the capstone. The material for each module will cover all topics in the corresponding IT area listed in Appendix A. Students will pay for each IT competency module they select in the bootcamp option.

**Pre-Course Self-Assessment**

Before registering the capstone course, students can evaluate their readiness to the capstone by taking the pre-course self-assessment exam, which is composed of selected multiple choice questions from all the IT competency areas. Concepts involved in these questions will be extracted from the comprehensive outcome assessment, and the result of the assessment will be reported to students immediately after exam completion. Students will then have better ideas about their levels of knowledge and skills in the corresponding IT areas, which will assist them in either choosing to proceed to the capstone course, or enrolling in the IT bootcamp to enhance their requisite knowledge. Appendix C illustrates the development timeline for the Excelsior College Bachelor of Science in Information Technology CBE Capstone Course.

**III. Key Performance Indicators**

The BSIT capstone improves the quality of our current, portfolio-based capstone. The goal of the proposed capstone is to ensure that students completing the course will be equipped with competencies enabling them to succeed in the IT industry. The Key Performance Indicators (KPIs) selected to evaluate the capstone course, therefore, are focused on both the course quality and student achievements after graduation. The identified KPIs are listed below:

**Direct measurement**
Course completion rate, which is calculated by dividing the number of students completed the capstone course and got a grade of C or higher by the total number of students enrolled in the course.

**Indirect measurement**

- Comparisons between pre- and post-course surveys asking students about their perceptions of their levels of knowledge and skills in the IT competency areas.
- Course evaluation from students, course instructors, and industrial mentors
- Students exit survey, which asks students about their perceptions of BSIT student outcome achievements and job-readiness.
- 1-year post-graduation survey, which asks our graduates to report their employment status and job satisfaction.
- Employer satisfaction survey, which asks employers of our graduates about their satisfaction of their performance.

**IV. Conclusion**

As a provider of competency based education, we believe that it is the College’s responsibility to ensure that students completing the program are prepared to meet the needs of the information technology workforce regardless of where or how they acquired their knowledge along the way. We expect the newly designed competency based capstone will enable our students to reflect, self-evaluate, prepare, and demonstrate their mastery of IT competencies to achieve their personal and professional goals. Our students will gain valuable project-based experience that includes the important critical thinking, teamwork, communication and decision-making outcomes, making them highly desirable candidates in the job market. Employers will find that graduates completing Excelsior College’s competency-based Bachelor of Science in Information Technology capstone course will enter the IT workforce equipped with the technical and workplace skills that are lacking among college graduates today.
Reference


Appendix A: Core IT Competency Areas

1. Database/Information Management
2. Networking
3. Software Development and Management
4. Human-Computer Interaction
5. Information Assurance and Security
6. System Administration and Maintenance
7. Web Systems and Technologies
8. System Integration and System Architecture

Source: ABET curriculum criteria
ACM (Association for Computing Machinery) IT BoK
IEEE SWECOM (Software Engineering Competency Model)
ACS (Australian Computer Society) ICT BoK
CIPS (Canada's Association of IT Professionals) IT CBoK
Competency Model Cleareninghouse (http://www.careeronestop.org/competencymodel/)
O*NET OnLine (http://www.onetonline.org/)
Appendix B: Excelsior College Bachelor of Science in Information Technology

Student Outcomes

1. Apply knowledge of computing and mathematics for problem solving in the field of Information Technology.
2. Demonstrate the ability to identify and analyze user needs to define and create appropriate computing requirements and solutions.
3. Demonstrate the ability to effectively select, evaluate, and integrate information technologies-based solutions in a user environment.
4. Demonstrate the ability to participate effectively in groups or team projects.
5. Demonstrate an ability to understand professional, ethical and social responsibilities, including the impacts of culture, diversity, and interpersonal relations.
6. Demonstrate proficiency in communicating technical information in formal reports, documentation, and presentations to users and IT professionals.
7. Demonstrate the ability to identify and analyze the impacts of information technologies and computing on public, organizations, and individuals.
8. Demonstrate the ability to identify and apply current and emerging technologies and tools for information technologies solutions.
9. Demonstrate expertise in the core information technologies such as data base management, information management and security, object-oriented programming, computer architecture, systems architecture, operating systems, and networking.
10. Demonstrate the ability to analyze computing and information security requirements and risks, and apply the appropriate tools and techniques to protect organizational data assets in an ethically responsible manner.
11. Demonstrate the ability to apply best practices and standards for information technology applications.
12. Demonstrate the ability to assist in the creation of an effective project plan.
13. Demonstrate a commitment to professional development and to continue to engage in lifelong learning.
APPENDIX C. BSIT CBE Capstone Course – Projected Timeline for Each Major Milestone:

Year 1 – Phase I
- Determine IT competencies
- Develop a concept paper/development plan
- Engage Stakeholders (advisory committees, dean/associate deans, industry partners)
- Program Committee Meetings
- Faculty Advisory Committee approval
- Develop capstone exams
- Identify industry partners/multimedia vendors
- Develop capstone projects

Year 1 – Phase II
- Engage Stakeholders (advisory committees, dean/associate deans, industry partners)
- Program Committee Meetings
- Develop/test capstone projects
- Develop IT bootcamp course

Year 2 – Phase I
- Engage Stakeholders (advisory committees, dean/associate deans, industry partners, center for professional development)
- Program Committee Meetings
- Develop/test capstone projects
- Develop IT bootcamp course
Year 2 – Phase II
- Engage Stakeholders (advisory committees, dean/associate deans, industry partners, instructors, students)
- Program Committee Meetings
- Develop/test capstone projects
- Develop IT bootcamp course
- Design discussion questions and portfolio assignments
- Faculty Advisory Committee approval
- Pilot IT capstone

Year 3 – Phase I
- Engage Stakeholders (advisory committees, dean/associate deans, industry partners, instructors, students)
- Program Committee Meetings
- Premiere IT capstone