Industry Connect Initiative Experience Report: Undergraduate Computer Science Courses

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ABSTRACT [1]

Southeastern Louisiana University is a medium sized university located in Hammond, Louisiana with approximately 14,000 students and ranks 59th best affordable Information Technology Program in the United States. Over the course of many years, what is now known as the "Industry Connect Initiative" (ICI) has been developed. The ICI is a four-pronged approach to connect students to real-world-ready skills and relevant topics. The four prongs of the ICI are the industry advisory board (IAB), internship program, distinguished lecturer series (DLS), and real-world curriculum opportunities (a.k.a. "Project classes"). In addition to the ICI, support from the university's Career Services Department and Workforce Talent Initiative completes the suite of resources resulting in graduates being highly sought after for employment.

While numerous implementations of real-world ready courses and project courses are widely available, the focus is only on the "capstone" or "major project". Even if the capstone course is multi-semester, this approach is limited as the real-world application occurs only at the end of the degree program. This paper details the ICI curriculum opportunity, a unique approach that incorporates these real-world experiences throughout a student's educational experience at a variety of difficulty levels, beginning in the third semester and culminating in the final semester in the Capstone course.

Keywords: STEM, Real-world-ready, Computer Science, Education, Computing Education Programs, Software Development Process, Collaboration in Software Development, Skills, Workforce, Collaborative Learning, Industry Partnerships, Group Work

1. INTRODUCTION

Southeastern Louisiana University is a medium sized university located in Hammond, Louisiana with approximately 14,000 students and ranks 59th best affordable Information Technology Program in the United States [9,10]. The Department of Computer Science currently has approximately 400 majors. Approximately 90% of graduates are employed upon graduation with a starting average salary of $59,900 [11]. The average salary of the state is $49,469 [1]. This success is in no small part due to the strong partnership between the department and industry. Over the course of many years, what is now known as the "Industry Connect Initiative" (ICI) has been developed.

The ICI is a four-pronged approach to connect students to real-world-ready skills and relevant topics. The four prongs of the ICI are the industry advisory board (IAB), internship program, distinguished lecturer series (DLS), and real-world curriculum opportunities (a.k.a. "Project classes") as shown in Figure 1 [2]. In addition to the ICI, support from the university's Career Services Department and Workforce Talent Initiative completes the suite of resources necessary for graduates to be highly sought after for employment.

The real-world curriculum opportunities consist of a suite of three classes: Software Engineering I, Information Systems and Capstone. Each class provides the students with opportunities to complete a real-world project with supervision and support

from industry professionals. Two courses, Software Engineering I and Information Systems, utilizes these professionals in the classroom to oversee that industry standards and best practices are adhered to and serve as guest lecturers on state-of-the art topics. This unique partnership with industry partners in the classroom sets the ICI apart and is tantamount to its success.

Figure 1. Industry Connect Initiative Overview [2]
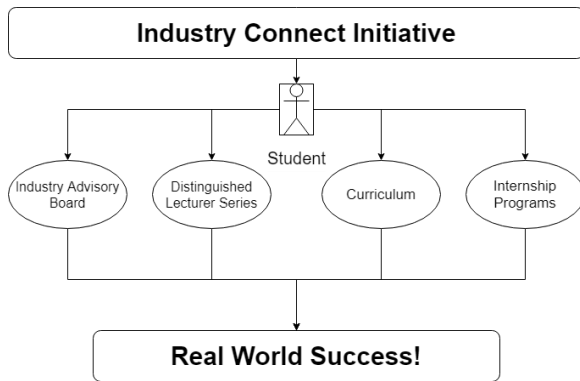
2. LITERATURE REVIEW

Providing real-world experience during undergraduate education has taken on a variety of forms including something as simple as opportunities to work with industry-grade tools. An increasing amount of attention, however, is moving towards incorporating "real world" projects in academic coursework [2-6]. A typical Computer Science, or related, program "capstone" adhering to the ABET guidelines requires a "major project that requires integration and application of knowledge and skills…" [7]. Beyond this specification, different programs are free to implement this in any manner of their choosing. However, as pointed out by Bloomfield, et. al. when students are given "toy projects" their interest may wane even if they have educational merit, as students may be looking beyond and realize it will not help them in the workforce [3]. Hence, focusing on bringing real-world problems and projects into the classroom can have real benefits.

While numerous implementations of this type of learning and project are available, many focus only on the "capstone" or "major project" [3-6]. Even if the capstone course is multi-semester, this approach is limited as the real-world application occurs only at the end of the degree program [3-6]. This paper presents a unique approach that incorporates these real-world experiences throughout a student's educational experience at a variety of difficulty levels, beginning in the third semester and culminating in the final semester in the Capstone course [2].

3. CURRICULUM OVERVIEW

Our curriculum is ever-evolving based on the recommendations of the Industrial Advisory Board (IAB) and the requirements of our accreditation board (ABET). Industry partners have suggested specific technologies, Computer Science concepts and best practices currently used in solving the software challenges and requirements of their clients. This ensures that students are up to date with the skills and technologies necessary to secure employment upon graduation.

Industry partners come from a wide range of industries including federal government agencies (e.g. Naval Research Lab), non-profit health insurance organizations (e.g. Blue Cross Blue Shield of Louisiana), and software development companies (e.g. Envoc, Elevator3, CGB, CGI). By and large the above-mentioned companies serve on our Industry Advisory Board (IAB), another prong in the ICI, and, as such, has recommended certain stack, software tools, and other third-party software programs for inclusion. The Computer Science department faculty members work diligently with the IAB to determine which of these suggestions can be successfully implemented. Discussion of the IAB is beyond the scope of this paper.

A sequence of Real-World Ready courses has geared its students' learning objectives to satisfy the recommendations set forth by the industry partners. The three courses are: CMPS 285 - Software Engineering I, CMPS 383 - Information Systems, and CMPS 411 - Capstone. A brief description of the courses and technologies used in each follow.

4. SOFTWARE ENGINEERING I

This class provides an introduction to the methods used for specifying, designing, implementing, and testing medium and large-scale software systems; methods for organizing and managing software development projects; and professionalism and ethical responsibilities in software development. Students are introduced to the Agile Process and each team member is required to present his/her contribution to the project on a weekly basis. Each team leader must communicate with the client regularly to ensure that the project development adheres to the quality
standards and requirements set forth by the client. Information Technology professionals are invited to both the midterm and final presentations. Each group is required to invite its client for the presentations.

The "hard skill" technologies taught in this class are: .Net Core, C#, API(s), Schemas and DataBase queries, Visual Studio Code, Github, and Controllers to and learn the difference between the front-end and back-end development. Additionally, it has become widely acknowledged that it is vital that soft skills be woven into the curriculum as they can make the difference in hireability [5,6,8]. To that end, the development of soft skills is included in the design of the course. Specifically, the course incorporates the soft skills of problem solving, responsibility, communication, public speaking, teamwork, and organizing and planning. A thorough discussion of this topic is beyond the scope of this paper.

The final documentation requirement is a portfolio including the following items: the Feasibility Study, the Software Requirements Specification document, and a User's Manual.

Elevator3, a local company in Southern Louisiana, owned by an alumnus, reached out to the instructor to collaborate on introducing a Real World Problem and establishing industry standards for the students to adhere to. For their semester project, each group secures a client and develops software as per the client's specification. The students present to their peers, faculty members, and industry professionals. Virtual links are provided to give industry professionals a convenient opportunity to attend. This was highly utilized, and in fact, one attendee was a database administrator with Microsoft Corporation, in Seattle, Washington, over 2,500 miles away. His attendance and, thus, expertise would have been sacrificed if not for the virtual option.

A Discord Channel is created and dedicated to student support. The focus of this resource is answering questions posed by the students in class. The greatest benefit of such a channel is the fact that it is open to the former students. This allows former students who are currently employed as software developers as well as current senior students to answer questions and interact with the class. The channel is moderated and monitored by the instructor. Additionally, each group has its own private channel to discuss the progress of the project as well as to allow the team leader to assign tasks to each member of the group. The resulting advantage of these private channels is that the instructor has a better understanding of each group member's performance and communication.

Grading is based on test scores, code contribution, communication, and portfolio. The test score is the average of two tests given at the midterm and end of semester. Code contribution is graded on the quality of code, quantity of code (i.e. lines of code). Communication refers to communication among group members and with the client as well as presentation skills demonstrated at the midterm and final presentations. The portfolio contents are detailed in Table 1.

The involvement of Elevator3 in the classroom portion of the curriculum represents the newest iteration in the evolution of the curriculum component of the ICI. At the end of the first semester in which they became involved, two students were selected for Internships at the company, thereby supporting the Internship Program prong of the ICI. Thus, Elevator3 represents support on all four prongs of the Industry Connect Initiative.

Table 1. Portfolio Contents

Request for Application	Presents the client and an overview of the project
Feasibility Study	Details the scope of the project.
Software Requirements	Describes the project's requirements in detail and includes client's signature
User's Manual	Details how to use the software

5. INFORMATION SYSTEMS

This class provides a study of file organization and management, analysis of the concept of information systems, and approaches and techniques for evaluating information systems. Fourth generation languages are explored. Upon completion, students will understand the intricacies of how information systems work. Because of this, many students have earned Internships because of their real world experience. Envoc, a local company whose founder and President is an alumnus of the program, has been an integral part of this class for the past 10 years. At least 10 students have gone on to complete an Internship at Envoc, eventually securing full-time positions.

The goal of this class is to grant students a realistic experience as a full stack developer working directly with a non-technical client. Gathering requirements, identifying problems, and proposing solutions that evolve over time are key to delivering software that will actually be used. It is emphasized that client communications not be treated as a normal homework assignment. Students are made aware that working with clients is a bi-directional channel that changes over time and advised that success in this class, as with most software projects in the real world, is measured in client satisfaction.

Every semester begins with the Instructor and three senior developers of Envoc meeting to finalize the software requirements for the semester project and decide which technologies will be used. This results in a framework that guides the students through the process. The pieces of the framework are: technical overview, project overview, client overview, phases overview, iteration overview, final phase, final presentations. The instructions that the students receive at the beginning of each semester comprising the framework follows.

Technical Overview
This project, like many, starts with a big dream that you must make real. You must work with your client to determine what is really needed to make this project a success. No matter what, there will be three parts to your solution: (1) the API, (2) a mobile app, and (3) a React website.

It is critical that you communicate with your client early and often. Be clear about expectations; be transparent about your goals and focus; and don't be afraid to shift directions should you and your client agree to a change.

Project Overview Guidelines
Each phase builds on the last. Example solutions will be provided to previous phases.

User Experience and polish of finished aspects are very important. Envoc acts as both the client and technical advisor. Client related questions should be worded in a non-technical way as much as possible. Technical questions can be as technical as you wish (e.g. How can I make a request to the API by utilizing react hooks?). The instructor requires ongoing feedback from each student individually which must go directly to him. Please submit feedback in a timely manner and provide as much information as you can on those forms.

Client Overview
Background: You work for a develop company and a new deal was signed for a rapid release project. The client, FoodToGo, met with your company's sales manager. Below are the notes from that meeting taken by your company's sales manager. A link to a

google document with the notes is provided to the students.

Phases Overview
1. Environment setup
2. "GIT Ready"
3. "API" (1 week)
4. "Databases" (1 week)
5. "Authentication" (1 week)

Iteration Overview
Once the final phase begins, you will meet with your client every two weeks for an iteration review. You will have very limited time for these as your client is busy. Most communication will be written via email. All client communications must include all group members, and cc the instructor. Be professional with your client communications, iteration reviews, etc. Don't be afraid to make mistakes. Both a client response and technical feedback will be provided. Phases prior to the final phase will review work at the end of that phase as needed. You must provide client notes after each iteration review. You will be given a google document for notes from each meeting. You and your team will be responsible for the contents of those notes and it will be emailed to the client shortly after each review meeting

Final Phase
- Have full pipelines confirmed (1 week in)
- Must have Create React App (CRA) build/deploy/publish
- Must have Expo build/deploy/publish
- Must have ASP.NET build/deploy/publish·
      Have first demo to client (2 weeks in)
- Must have notes
- Must demo from deployed site/app
- Every odd week - lecture/questions
- Every even week - client review

Final Presentations
Industry professionals are invited to watch the presentations. Most attendees share valuable technical feedback with the instructor which is then communicated to the pertinent students.

The final presentations mark the conclusion of the class. It is common for Envoc as well as other industry professionals in attendance of the presentations to interview select students for Internships. Thus, Envoc represents support on all four prongs of the Industry Connect Initiative.

6. CAPSTONE

Through participation in a major capstone project, this course presents a formal approach to the top-down design, development, and maintenance of software systems. Topics include organization and management of software projects, security, programmer teams, validation and verification. Students are free to choose whatever Stack they deem, as well as any software tools. This class requires that students have a real world client and produce working software by the end of the semester. All code must be stored in a repository, such as GitHub and the instructor must be given access to the account. Students grades are based on four components: code contribution, team communication, mid-term and final presentations and documentation / portfolio. Sample projects are outlined below:

MC:

Client	Department Head, Department of Biology
Description	Computer Vision based Micro-organism classifier that uses the OpenCV library to classify images, as well as the pyplot (and similar) libraries to display distributions, etc of sample sizes.
Technologies	MERN Stack, Python (OpenCV, pyplot libraries

Saturn:

Client	The Dean of the Science & Technology College
Description	A webservice with the aim of being what will hopefully be the defacto standard for unofficial and official clubs to recruit members.
Technologies	Rust, Web Assembly, Diesel ORM (PostgreSQL), Rocket, Yew

SLU Pipelines Mobile:

Client	Sustainability Manager
Description	Mobile app that provides workers on campus with information regarding various buildings on campus and the ability to see different meters and valves across campus on google maps
Technologies	React Native, Google Maps API

The Detector:

Client	A Computer Science Professor
Description	Attendance software that will scan the students' faces and match the pictures saved at Southeastern to make sure that only the students enrolled in class are attending.
Technologies	TensorFlow, Python for AI

SRD:

Client	A College of Business Professor
Description	Create a memorial web app to honor veterans. The web provides a one stop site for family and friends of a deceased soldier/veteran to visit and honor him/her. It showcases some basic information of the deceased soldier/veteran such as name, war, branch, services, rank, deceased date, short bio, photos, and video, etc.
Technologies	Angular, Ionic framework, Firebase

From the above-mentioned projects, one can see that the students have used a variety of different stack and software tools to develop their software. All students are required to share their repositories with the instructor as the grade is based on code contribution. There is also a required project portfolio that contains the same documents as the one detailed above in the Software Engineering course. Once again, the success of the ICI is demonstrated as this past semester, approximately 50% of the attendees at the final presentations were industry professionals and approximately 30% of the students were approached by the industry professionals for resumes. Additionally, recruiting companies are regular attendees and consistently approach the instructor to align the students with job opportunities.

7. CONCLUSIONS

The Industry Connect Initiative (ICI) is an innovative four-pronged approach to connect students to real-world-ready skills and relevant topics. The four prongs of the ICI are the industry advisory board (IAB), internship program, distinguished lecturer series (DLS), and real-world curriculum opportunities (a.k.a. "Project classes"). In addition to the ICI, support from the University's Career

Services Department and Workforce Talent Initiative completes the suite of resources resulting in graduates being highly sought after for employment. This paper details the Curriculum Opportunity prong of the ICI. The Curriculum Opportunity is a unique approach that incorporates real-world experiences throughout a student's educational experience at a variety of difficulty levels, beginning in the third semester and culminating in the final semester in the Capstone course [2].

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