2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
Paper ID #38647

Board 4: WIP: An Integrative Remote Patient Monitoring Industry-Classroom Program for Undergraduate Biomedical Engineering Students

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Work in Progress: An Integrative Remote Patient Monitoring Industry-Classroom Program for Undergraduate Biomedical Engineering Students

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Abstract

The at-home remote monitoring sector of healthcare is a growing industry. This healthcare market is valued at $24 billion, and it is projected to reach $166 Billion by 2030 [1]. This growing industry has unique challenges and can promote unique learning opportunities for undergraduate biomedical engineering students [2]. A collaborative industry-classroom program was developed along with Ohio At Home Health Care Agency, LLC, a local remote patient monitoring company. This new program was envisioned to prepare upcoming biomedical engineering undergraduate students for the needs, technology, and opportunities in the industry of at-home remote patient monitoring.

The program was created with both academic and industry outcomes in mind. This program was structured as a semester-long internship with weekly classroom meetings. While in their internship, the students worked shifts in remote monitoring, interacting with patients and communicating with them. They also work on weekly professional reflections to report on their experiences. They attend two seminars throughout the whole experience on policy, legislation, or any other business requirement. Students are required to perform two interviews with stakeholders or individuals integral to the business. The experience culminated with a project that required students to create a solution related to disability policy, workforce management, health/behavioral safety, or technology in the company. In the classroom, students were assigned complementary readings on the design process, completed weekly reflections on their learning experiences and weekly readings, and discussed the project, the progress, and the resources they required from either faculty or industry mentors.

Being a pilot program, a few challenges were identified. The challenges include framing an adequate assessment framework and balancing the synergy between the work students perform inside and outside the classroom. The current solution to tackle these challenges was implementing a professional identity assessment [3], as well as utilizing the reflections to better understand their experiences and what needs arose from the program.

Introduction

The at-home remote patient monitoring sector of healthcare is a growing industry. This healthcare market is valued at $24 billion and is projected to reach $166 Billion by 2030 [1], [4]. This industry provides individuals with disabilities or chronic medical conditions with new levels of independence by allowing them to remain at home. These companies leverage technology and personally crafted care plans that address the needs of their clients. The technologies involved include cameras, medical or environmental sensors, and interfaces with at-home medical devices (e.g., ventilators and glucose monitoring). These services can also communicate between medical providers, support networks (e.g., family and friends), and direct support (e.g., nurses at home). This growing industry poses unique challenges and can promote unique learning opportunities for many students, specifically undergraduate biomedical engineering students [2]. Biomedical engineering students are a perfect fit for this type of industry as their training includes technology, medicine, and the synergy between the two.

This paper presents a new industry-classroom course developed to allow undergraduate biomedical engineering students at The Ohio State University (OSU) to work in a local remote patient monitoring company (Ohio at Home Healthcare Agency). This course allows students to work as remote support associates (RSA) while tasked with developing a project around a specific business solution. On top of that, the students meet weekly with the instructor to complete reflections and read about design concepts. This paper will also present a plan to assess the learning outcomes for the course and identify the growth students might experience.

Course Structure

This course has been offered in Fall 2022 and Spring 2023, and is being offered during Summer 2023. This course is a three-credit elective course set up as an independent study. The curriculum at the Department of Biomedical Engineering at Ohio State allows students to take up to 4 courses called career electives intended to give a student a choice to build specific skills for their desired career path. This industry-classroom course was approved to be one of the professional elective courses giving the students an incentive to take it. The only requirement for this course was being admitted to the BME major and wanting to take the course. As part of the course, the company also reimbursed students for any required training and paid them at a rate of $10/hr. The course learning objectives (LOs) are:

- *Students will be able to:*
    - *LO1: Develop a solution to industry challenges by understanding patient needs, business priorities, and design requirements.*
    - *LO2: Grow their professional identity by working in a new out-of-classroom environment.*

The course had two components: an in-classroom and an out-of-classroom. The in-classroom component was a minor element, requiring students to complete weekly reflections and participate in discussions about topics from the Yock et al. e-biodesign book [5]. The out-of-classroom piece represented most of the student's work, including training, work shifts, and project work. Students were required to complete an 8-hour training offered by the state's Department of Developmental Disabilities (DoDD). This training encompasses topics like the bill of rights for people with developmental disabilities, trauma-informed care, health and safety, and empathy-based care to name a few modules. The overall takeaway for students was to be informed of the rights of individuals with developmental disabilities, how to provide proper direct care, and HIPPA regulations.

Students also needed to complete a CPR and First Aid certification as part of the program, which expenses were covered by the company. In preparation for their work as an RSA, students were also trained on the role of an RSA, what it means to provide remote support, communication strategies, and expectations on what a shift entails. Students received training on the specific patient's remote support service plan (RSSP), what constitutes a major unusual incident (MUI), and an unusual incident (UI) that requires reporting. Additionally, students were introduced to the equipment and applications that Ohio at Home utilizes to communicate with their patients.

The last component of the out-of-classroom was the project students needed to complete. Some examples of projects from the previous semester (AU22) include creating educational material and frequently asked questions for potential clients of Ohio at Home or creating a detailed process flow for newer clients entering the remote support service. In the current semester (SP23), students are pursuing more technical projects, including collaborating with a medical technology company to implement a pulse oximeter in patients' homes. Also, create a solution to integrate the company's communication protocols with an already deployed medical monitoring device. The authors want to clarify that the vagueness of some of these descriptions is to protect the company's IP and technology development.

Planned Assessment

The students are evaluated and assessed in multiple stages. The initial assessment is informal and is performed by the company's CEO and technology innovation officer. This assessment pertains to the student's progress, overall professional aptitude, and motivation in the projects being pursued. The second evaluation is a weekly reflection where students write about their week, what they have learned, and what takeaways they have from the assigned readings. During class time, these reflections are then discussed. At the end of the semester, the students are tasked with creating a presentation of their deliverables to the company's CEO, innovation officer, and HR representatives.

Given the unique opportunity this experience represents. The authors plan to assess this experience further using an engineering professional identity inventory created by Patrick et al. (2017) [3]. This instrument evaluates a student's self-perceived affect towards elements of the engineering practice rather than aspects of academic efforts. This instrument fits properly with our learning outcome of having students: "*Grow their professional identity by working in a new out-of-classroom environment.*" A survey will be deployed at the beginning and end of the student's experience. This instrument will measure five constructs: Analysis, Collaboration, Design, Framing and Problem Solving, and Project Management. The entire list of items is included in Appendix 1. The students will also be asked about their gender, current year, and career aspirations (e.g., industry, graduate school, medical school, or other). The goal of this assessment is twofold: allow students to reflect on their professional identity (LO2) and how the industry experience may alter their perceived notion of the professional engineering identity.

Observations and Future Plans

Given that this study is still under Internal Review Board (IRB) review, only observations can be shared from the faculty and industry partner. In the two semesters the course has run, the students and industry partners have provided positive feedback for the experience. The students have found the experience valuable and rewarding. They have expressed satisfaction in learning how to work in an industry environment and with open-ended projects. They are also surprised how their work can quickly impact the outcomes of clients of Ohio at Home. On the other hand, students gave feedback on how the course could be better organized, and expectations could be better communicated. An area of opportunity for the course is identifying the projects before the students engage with the course. This would give the students a better sense on what they will be working on.

The industry partner has expressed how outstanding the students have been to work with and have impacted the development of new business solutions. They have noted how the BME students have utilized their skills in synergy and research to better communicate with patients, engineers, and employees within the company. Some concerns the industry partner has raised is around programming and the student's lack of training. This concern ties to a broader challenge within the OSU BME curriculum that does not prepare students for the level of programming required. In the future, the industry partner will aim to include programming booth camps to ensure the students are prepared to handle these challenges.

The future plan for this course is to become an official course. Currently the course is offered as an independent study which does not require a syllabus and it is graded as a pass/fail. As the summer semester ends and assessment is collected, the course will be submitted for approval as an elective within the department.

Conclusion

This course gives undergraduate biomedical engineering students a unique opportunity to participate in a paid internship while learning about a new healthcare field of remote patient monitoring. The goals of the course are for the students to grow as engineers, practice working in an industry environment and develop their professional identity through experience. For the following steps, once an IRB has been submitted, the authors will collect an assessment to understand better how this course can impact the student's development and professional identity.

Appendix 1: Survey Questions

Survey Wording	Dimension/Category
Applying my math knowledge and skills	Analysis
Using calculations and equations to evaluate things	Analysis
Identifying what I need to know to solve a problem or complete a project	Analysis
Communicating verbally, for example in discussion with others	Collaboration
Presenting my work to others	Collaboration
Working with people with different skills and interests	Collaboration
Convincing others to accept my ideas	Collaboration
Breaking a complicated problem into smaller parts	Collaboration
Working collaboratively in teams	Collaboration
Identifying technical solutions that are as simple as possible	Design
Designing and conducting experiments to test an idea	Design
Improving a design to make it more efficient (faster, better, cheaper)	Design
Searching for innovative ways to do things	Design
Using technology to solve environmental problems	Design
Creating prototypes to test an idea	Design
Designing a system, a part/component of a system, or a process based on realistic constraints	Design
Solving problems that allow me to help a lot of people	Framing and problem solving
Learning new things from other people I'm working with	Framing and problem solving
Finding a better way of doing something	Framing and problem solving
Continually learning new things	Framing and problem solving
Applying my science knowledge and skills	Framing and problem solving
Being curious	Framing and problem solving

Planning a project and staying organized to complete it	Project management
Using facts and information, instead of opinions, to make decisions	Project management
Seeing a project through to its end	Project management
Tracking various aspects of a project to ensure that it stays on track	Project Management

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