Board 8: Work in Progress: Bridging Theory and Practice: Innovation-Based Learning and NSF I-Corps in Modern Engineering Education.

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Bridging Theory and Practice: Innovation-Base Learning and NSF I-Corps in Modern Engineering Education

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I. Abstract

This study investigates the mechanics of integrating the National Science Foundation's Regional I-Corps program (NSF I-Corps) with a Biomedical Engineering class using Innovation-Based Learning (IBL). This work will explain how a multi-student-led project advancing repetitive Transcranial Magnetic Stimulation (rTMS) participated in a Regional NSF I-Corps cohort. The project team consisted of both graduate and undergraduate students in a hands-on, authentic engineering learning environment. This study aims to document the experience of this educational approach by conducting interviews with student team members, instructors of the IBL program, and an industry mentor from the NSF I-Corps program. The research methodology involves semi-structured interviews with a qualitative and quantitative analysis to better understand the various groups involved in this initiative. This work aims to understand the potential benefits and challenges of the I-Corps and IBL integration. By examining the feedback of students, instructors, and mentors, the study seeks to document the experience of all stakeholders in the process and to identify how this approach may enhance practical skills, foster innovation, and improve market readiness among engineering students. While the study presents preliminary results at this stage, it aims to establish a foundational understanding of the potential implications of using the I-Corps NSF program in an engineering IBL classroom. The insights gathered from this study can inform future curriculum development, teaching methods, and the overall approach to engineering education, focusing on preparing students to meet the growing needs of the industry and contribute to regional and global technological advancements.

II. Introduction

Focusing on theoretical knowledge dominates the engineering education landscape [1]. However, the rapid changes in the modern world render this approach increasingly inadequate for the engineering industry's needs [2]. This highlights the urgent need for a shift in educational models to better equip students for real-world challenges [3]. In response to the need for more authentic engineering education, Innovation Based Learning (IBL) was developed. IBL is an educational system encompassing various elements such as mastery, peer learning, review, mentorship, tokenized curriculum, and more [4]. Its core principle can be distilled down to one concept: students are evaluated based on their ability to generate value.

The NSF Regional I-Corps (Innovation Corps) program is an initiative by the National Science Foundation (NSF) to foster innovation and entrepreneurship. It provides training, mentoring, and funding opportunities to help researchers and scientists transition their academic research into commercial ventures. Regional I-Corps programs typically involve workshops, networking events, and guidance from experienced entrepreneurs and industry experts to help participants validate their technology's commercial potential and develop market entry strategies. By engaging directly with potential users or customers, students gain valuable insights into market needs and the practical viability of their innovations. This process ensures that the

solutions developed are aligned with the actual needs and gaps identified in the industry [5]. Students from participating institutions are not required to pay a fee to participate in Regional NSF I-Corps. [6]. The student group proposed participating in the NSF Regional I-Corps program as their means to generate value for their project.

III. Educational Framework

Innovation-Based Learning (IBL) is a learning model grounded in student autonomy that values innovation and creating real-world impact as essential elements of the learning process [7]. Within the IBL framework, instructors collaborate in a teaching environment where multiple educators serve as experts, providing guidance and feedback to the students on their projects [8]. The university offers some IBL courses as electives while making others mandatory for undergraduate and graduate programs. Every IBL class includes participation in group projects; within these class projects, students need to identify three elements: 1) Gap: Students need to identify and address a need within the industry or society, encouraging students to apply their curiosity and innovative searching for relevant scenarios. 2) Solution: Students need to develop an engineering solution that addresses the gap [7]. 3) Impact: Students must externalize the value created in class through their chosen avenues. These avenues can vary widely, such as academic papers, abstracts, conference presentations, or, in this instance, participation in an NSF Regional I-Corps cohort [9,1].

The mandatory IBL course in question consists of 45 students, comprising both graduate and undergraduate students, with a mix of online and on-site attendance. The student group studied in this paper comprises 5 students and the project aims to further the development of repetitive Transcranial Magnetic Stimulation (rTMS) technology.

Getting involved in NSF I-Corps offers great educational opportunities. By bringing innovative solutions to the market, student participants can have a direct positive impact on society. Participating in the NSF I-Corps program as part of an IBL approach is one way to create real-world impact, offering students a unique opportunity to validate their innovative solutions in the market and contribute to societal advancement. However, this innovation-based and entrepreneurial approach may need to be more generalizable to traditional classroom settings, where the focus is often more on theoretical knowledge and less on hands-on, market-driven experiences.

IV. Methods

We will employ statistical regression analysis to predict the impact of the NSF I-Corps program on IBL-related skills such as adaptability and critical thinking. MATLAB will be used to study the open-ended survey questions by identifying common themes and patterns using aggregation and summary statistics.

The subjects in the study will include 5 IBL student team members –2 first-year undergraduates, 1 third-year undergraduate, 1 PhD student, and 1 Master's student – along with an industry mentor from the I-Corps program and three IBL instructors. Data collection will involve semi-structured interviews with all team members, IBL instructors, and I-Corps industry mentors. The interviews will follow the approved Institutional Review Board (IRB) protocol #IRB0005941. The interview questions will be based on validated surveys from similar peer-reviewed studies.

V. Results (Work in Progress)

This is a work in progress. At present, we are conducting and analyzing the interviews with the following participants – four students, two IBL program instructors, and the NSF I-Corps industry mentor. Initially, five students participated in the I-Corps cohort; however, one did not wish to participate in the interviews. Detailed results, including the analysis of surveys and interviews, will be presented in the future full paper of the study, focusing on the effectiveness of integrating the NSF I-Corps program in IBL.

Through our project, we met two of the three IBL course criteria (Gap and Impact) due to the NSF I-Corps program. Within the program, we identified a gap in the rTMS industry through interviews with clinicians, patients, and insurance companies. This contributed to meeting the impact criteria for our IBL course by presenting the current need in the rTMS industry to the NSF. By providing an unbiased interpretation of participants' experiences and perspectives, we aim to offer a comprehensive assessment of the effectiveness of the NSF I-Corps program within an IBL classroom.

VI. Discussion

As the study is still in its early stages, we don’t have strong validated results, but preliminary analysis suggests integrating the NSF I-Corps curriculum with IBL shows promise for enhancing entrepreneurial skills, adaptability, and critical thinking among engineering students. Participants gained insights into market dynamics through hands-on learning, indicating early signs of adaptability and critical thinking. However, not all team members participated in the interviews, potentially affecting reported experiences. Given that we were only 5 students in a 45-student IBL course who participated in the NSF I-Corps, the significant time commitment required by the program - 15 hours a week per week for each team member over seven weeks – may have hindered some student’s ability to engage in the project entirely. A more feasible approach may students enrolled in multiple IBL courses, as this would better align better with the time demands of the NSF program. Some results are based on self-assessed opinions, which may not reflect actual outcomes. Further analysis may be needed to better understand the impact of I-Corps and IBL on engineering education.

VII. Conclusion

As this study is in its early stages, a definitive conclusion regarding the impact of integrating IBL principles with the NSF I-Corps program in engineering education is yet to be drawn. However, the preliminary findings point towards a positive experience. Future research will include interview responses and response analysis, which will draw the study conclusions and recommendations for enhancing practical, authentic learning experiences within engineering curricula.

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