Board 275: Exploring the Impact of Industry Partnerships to Promote STEM Careers in Rural Middle Schools

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Abstract

This paper explores lessons learned about the developing and sustaining high-quality industry partnerships during a NSF Innovative Technology Experiences for Students and Teachers (ITEST)-funded community-based engineering design course centered on advanced manufacturing. The three-part course for underrepresented middle school students in rural NC launched in 2020 and has served over 100 students to date. The project aims to allow students and teachers the opportunity to explore the full range of STEM advanced manufacturing career options available in their local community. Students learned STEM content as well as technical and job essential (soft) skills necessary for future employment; while, teachers boosted their knowledge of STEM, local STEM careers, and pedagogical skills. Industry partners developed a pipeline of STEM talent for future recruitment, expanded corporate outreach, and highlighted potential career opportunities within their company.

This project boasts meaningful industry partnerships with local companies including Pfizer, Cummins, Kaba Ilco Corporation, LS Cable & System, Hitachi, and Poppies International that allowed students to study three broad areas: energy systems, food science, and pharmaceuticals. These partnerships were cultivated through intentional outreach with the school district and a regional STEM advocacy organization. Each participating partner was asked to actively engage in the project by acting as project advisors, collaborating on curriculum development, mentoring students, serving as invited guest speakers in the classroom, and hosting virtual and site tours of their manufacturing facilities. To ensure the industry partners remained engaged, project leaders provided clear and consistent communication through written updates and virtual meetings, offered multiple opportunities for participation, and solicited feedback designed to help improve the project.

Introduction

Partnerships between educators and industry leaders have grown in an effort to motivate and inspire students to explore and understand opportunities in STEM. School curricula have adapted more hands-on activities and emphasized STEM learning in the classroom. Given the right ecosystem, often these result in increases to STEM attitudes among youth [1]. In a study by Pattison, providing students with hand-on experiences where they can simulate a real-world problem with actual STEM industry professionals exposed students to authentic learning, helping increase student agency and critical thinking [2]. In turn, the exposure to STEM learning aims to increase recruitment to the STEM field. In most cases, the impacts of these partnerships have also presented an opportunity to increase recruitment into the STEM workforce, particularly

developing programs that emphasize the recruitment and mentoring of women and students of color in STEM [3]. However, some partnerships also acknowledge the challenges to maintaining student interest, particularly as it relates to right fit into a field or industry and if a student feels connected to the industry [4].

Where partnerships between education and industry partners also find the most value occurs professionally among the educators themselves. While students and access to student recruitment is often seen as the ultimate goal for industry partners [5], most educators also benefit from a professional development opportunity to learn more about the STEM field and figuring out what pedagogical opportunities exist to help students in their STEM understanding and learning [6], [7]. In a study by King et al., pre-service teachers worked closely with industry partners through a program called STEMROD, where teachers were tasked with implementing a STEM hands-on learning experience for their classrooms through recommendations made by industry partners [8]. While some challenges did exist, pre-service teachers valued the professional development and autonomy they were afforded through the partnerships they had with industry leaders.

Important to note is the impact COVID-19 had on these partnerships and whether an event that forced the world to isolate from each other could have a negative impact on student learning and the hands-on experience valued in STEM education. While education turned to virtual learning and educators felt like they would lose student engagement, industry partners were able to pivot effectively and still provide students' access to the STEM field in alternative ways. For example, Gurn et al. noted how they turned their internships to virtual check-ins and mentoring opportunities [9]. Rather than focusing on the hard skills needed for a job, industry partners arranged meetings with students that focused on soft skills, such as job interviewing and professional socialization. In another study, industry partners leveraged their workforce connections to help educators and their schools gain access to external grant funding and resources to maintain the hand-on experience in the classroom and virtually[10]. While the experiences were non-traditional and was a gradual adjustment for students, engagement between students and educators with industry partners remained at a high level.

Project Description

The ITEST project entitled, *Developing STEM Identity in Rural Audiences through Community-Based Engineering Design (DeSIR*E), is a four-year project that connects rural underrepresented middle school students (grades 6-8) to STEM career opportunities in the advanced manufacturing industry in their local community. The 3-part grade-level specific engineering design elective courses are deployed at two different middle schools in the same school district. The courses allow students to explore real-world engineering design challenges. The aim is to increase student interest in STEM careers and develop a sense of STEM-identity. DeSIRE is a collaboration between the College of Engineering (COE) and the Friday Institute for Educational

Innovation within the College of Education (CED) at North Carolina State University (NCSU), the North Carolina Mathematics and Science Education Network Pre-College Program (MSEN), a rural school district in NC, and local advanced manufacturing companies.

A major hallmark of the project was the development of meaningful and productive relationships with individuals employed at participating advanced manufacturing companies. These industry partnerships have proven to be impactful on the project throughout its initial development and subsequent implementation. Local companies including Pfizer, Cummins, Kaba Ilco Corporation, LS Cable & System, Hitachi, and Poppies International, represent three different areas within the advanced manufacturing space- energy systems, food science, and pharmaceuticals. These partnerships were cultivated through intentional initial and ongoing outreach efforts with the school district and a regional STEM advocacy organization. Each participating industry partner was asked to actively engage with the DeSIRE project team.

Data Sources

Information about industry partner activities and lessons learned are derived from project artifacts which include meeting agendas and minutes, classroom and project event observations, and interviews with industry partners, teachers, students, and content developers.

Industry Partner Activities

Throughout the project DeSIRE, project staff sustained a high level of engagement with industry partners. Industry partners advised project staff, served in a mentoring capacity, and offered opportunities to "view" industry facilities.

Advise DeSIRE Team Members

Project meetings, phone calls, and emails allowed industry partners and DeSIRE team members to establish a rapport. Industry partners advised team members about the skills and technical know-how their future employees (current students) should possess. During the project kick-off meeting, industry partners offered suggestions when selecting which Engineering Design Process model to select for use with students. Additional topics of discussion included potential curricular content, sample project design ideas, and proposed ways to connect with students and teachers. One of the course content developers expressed his appreciation for industry partners during an interview about the project. He spoke about the opportunity to engage with partners and how participating in the project was based on mutualism. It was beneficial to the project team and to industry partners by potentially allowing them to add to their future workforce. He stated,

> And that's why the strength of a good advisory board, good mentorship with expertise to bring us together. With our industry partners, as an example, because they need talent, we can engage them in a meaningful way to help us shape our course.

Mentor students

Industry partners served as mentors for the students. They actively shared information about their path to a STEM career and the information about the company at which they were employed. They discussed educational opportunities experienced along the way including what postsecondary institution they attended offering information about their chosen four-year institutions or community college. In some cases, they shared information about their hobbies. An effort was shown to connect with students in a personal way to ensure they were viewed as a real person who attained professionally what a student might aspire to. Each company was invited to attend a year-end showcase where students were able to share the results of their final project. Participating staff members interacted with students as they viewed the projects from each student group. Staff could be heard asking about the process and outcome of the projects. After the showcase, representatives remained for the awards portion and dined with students.

Allow a Glimpse into the Manufacturing Facilities and STEM

Industry partners served as guest speakers sharing information about their company, the products it made, and the underlying science and engineering. Plans for the project initially called for industry partners to allow student tours into manufacturing facilities. Due to Covid-19 and constraints related to the age of students, a shift to virtual or video tours occurred. One of the teachers shared the importance of offering students the ability to learn about the physical environment in each company, potential jobs, and how some of the products made impact their daily life. He offered,

> One of the things that hasn't happened that I would like to happen is, I would like to see the students be able to visit the facilities in our area that are sponsoring the DeSIRE program so they can see what's available in the area. For example, it's hard to encourage someone to be involved in Cummings, building diesel engines all day long, when in their mind [students] they see themselves with a wrench and a bolt and tightening down the wrench and greasy. When we actually get to go there, it will be full of technology, full of robotics. It will be a very clean job, people interacting with each other. There are all kinds of occupations available in that one system. I have a number of students whose parents work at Pfizer. They have no idea what their parents do, what technology is available in there. So, I think when we get to the point where we can actually visit some of the technologies that are there, it will benefit the children.

The teacher subsequently shared information about a product made at one of the facilities. He explained,

> Kaba Ilco is the largest manufacturer of keys and locks. I tried to explain to them that the key fob that their parents have on their car comes from Kaba Ilco. But if they could go there and see it, I think that they ought to have that experience.

While students did not have the opportunity to visit in person, DeSIRE teachers did have the opportunity to enter facilities. They participated in virtual and in-person tours as well as a teacher externship which allowed one of the teachers to spend a full week onsite shadowing company engineering staff. The teacher shared,

> Actually I signed up to be part of the Teacher At Work Program and I was lucky enough to get into Cummings. I spent four days at Cummings and crawled the plant from one end to the other. So I have a better understanding of what to tell people.

Industry Partners Best Practices

Start Strong

The manner in which partnerships are developed matters. For DeSIRE, a kick-off meeting allowed partners to connect, establish ground rules, and set goals for the partnership and the project. An effort was made to honor the expertise of the partners by including their ideas in the development of course content. Starting in this manner allowed for project buy-in and a collaborative commitment to the mission and goals of the project.

Leverage Existing Community Resources

University partners should recognize the value in the existing community assets and infrastructure. Utilizing those resources to initiate discussions for how new projects could fit and allow access to innovative projects that could benefit its residents. Connecting through local chambers of commerce or similar organizations could prove to be beneficial. The DeSIRE team connected with the local school district as well as an organization designed to improve the quality of life through economic development. The Strategic Twin-Counties Education Partnership (STEP) had existing relationships with companies in the area and was instrumental in facilitating connections to local industry.

Ensure Consistent Communication

Timely and consistent communication is crucial in the development and success of long-term partnerships. Project staff connected in-person and virtually for periodic meetings with industry

partners. DeSIRE staff provided easily digestible yearly updates to industry partners and other key stakeholders via graphical reports that shared project milestones, outcomes, and goals met. Additional updates were provided via the project website.

Summary

Increasing the number of students who enter the STEM pipeline is imperative. To meet this noble goal, increasing student interest and enhancing their STEM knowledge may assist in spurring students to pursue careers in a STEM field. The development of industry partnerships may be a way to ensure students have an opportunity to learn more about companies within their local community and to interact with STEM professionals.

The DeSIRE project staff worked diligently to create an environment that facilitated strong connections with the industry partners. Industry partners served as official project advisors offering suggestions about content, mentors to students, and ambassadors to their company. From the project, a number of best practices emerged that can serve as a guide for those desiring to create similar partnerships in the future. Best practices for industry and university partnerships include beginning the connection with strong communication to allow for tone and goal setting, leveraging existing community resources such as a chamber of commerce or other connector group familiar with local industry, and communication project progress and accomplishments regularly.

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