Student Engagement – Faculty Support for Club Activities

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Student Engagement – Faculty Mentorship in Engineering Clubs: A Longitudinal Study

Abstract

This paper focuses on faculty mentorship in supporting student engagement through extracurricular engineering clubs at Vaughn College of Aeronautics and Technology in New York. Since the establishment of the Mechatronic Engineering program in 2008, followed by Mechanical and Electrical Engineering programs, faculty members have recognized the value of structured co-curricular experiences to extend classroom learning and foster professional growth. Faculty advisors have actively guided the development of student organizations, such as the Robotics Club, UAV Club, and the Society of Women Engineers (SWE) – College Chapter, providing mentorship in project planning, technical problem-solving, leadership, and community engagement.

Through competitions, workshops, and outreach events, students have applied engineering principles in real-world contexts, developed teamwork and leadership skills, and deepened their understanding of engineering as a career path. Faculty involvement has also enabled students to present at professional conferences, lead workshops for pre-college students, and integrate competition projects into capstone design experiences. Over more than a decade, these mentorship-driven activities have contributed to measurable student outcomes, including advanced technical skills, professional preparedness, and leadership growth, while simultaneously sustaining community-engaged initiatives. This paper shares faculty strategies, lessons learned, and longitudinal evidence that can inform other institutions seeking to enhance student engagement, experiential learning, and community impact through faculty-supported co-curricular programs.

INTRODUCTION

Vaughn College is a small private institution located in a busy metropolitan area, serving one of the most diverse student populations in the nation. Designated as a Hispanic-Serving Institution (HSI), more than 85% of students come from minority, low-income, first-generation, or new immigrant families. Despite these demographics, the college has been recognized for regional academic excellence and strong generational income growth [1].

Since 2008, the college has offered a B.S. degree in Mechatronic Engineering, integrating mechanical, electronic, and computer engineering curricula. Mechanical and Electrical Engineering programs were added in 2013. All programs have earned ABET accreditation, and the Mechatronic Engineering undergraduate program is one of only ten in the United States up to now [2]. The Industrial Advisory Committee (IAC) provides guidance on current industry trends, however, faculty recognized that students required **daily hands-on engineering practice, teamwork, and leadership experience** beyond the classroom. Particularly nowadays, due to the rapid development of Artificial Intelligence (AI), more and more learning duties can be resulted in skills applying the assistance of AI to solving various problems in the real-world. Gradually, higher education can be more towards students' experiences in the interactions with communities, finding problems and searching approaches to solving the problems, as well as teamwork effort development in colleges [3].

The college engineering faculty members consider that faculty mentorship can play a pivotal role in addressing this need. By advising student-led clubs, organizing competitions, and facilitating workshops, faculty provide structured support for students to apply technical knowledge in the real-world, natural, and highly realistic environments. Faculty involvement ensures continuity, helps students navigate challenges, and fosters long-term engagement, enabling both **student skill development** and **community outreach**. Over the past decade, faculty-supported club activities have demonstrated sustained impact on student learning, professional preparation, and community engagement.

SOCIETY OF WOMEN ENGINEERS (SWE) – VAUGHN CHAPTER

The need for female engineers in both a professional context and education has long been recognized. According to the U.S. Department of Education, National Center for Education Statistics [4], the female number of B.S. in engineering increased from 3.4% in 1976 to 19.5% in 2006. Particularly, recognizing the underrepresentation of women in engineering, faculty advisors helped to establish the SWE – Vaughn Chapter in 2015, providing guidance on leadership, recruitment, and program development. Faculty mentorship ensured the club aligned with students' interests and professional opportunities while integrating outreach into local communities.

Faculty led students in designing and delivering hands-on workshops for high school students, connecting engineering concepts to engaging, creative projects, such as wearable electronics headbands, microcontroller-controlled Light Emitted Diodes (LEDs), and craft-based activities (Figure 1). With the faculty's help, the workshop was documented and presented at professional conferences, including the 2015 IEEE WIE Forum, with faculty guiding the SWE club students through submission, presentation, and leadership experiences (Figure 2).

Figure 1: The 1st Workshop with High School Students

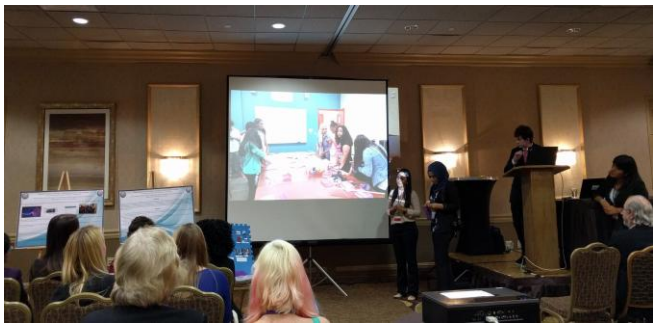

Figure2: Organized a Workshop at 2015 IEEE WIE FORUM

Activities held by the SWE – Vaughn Chapter on various workshops have been continued, including projects like electric pianos and electrical blowers (Figure 3a and 3c). Faculty mentorship has supported students in submitting educational research papers, attending conferences, and developing leadership skills. Among the conference presentations, the project involving the construction of an electronic piano, entitled **"Creating Interest in Engineering with Girl Scouts"**, attracted significant interest at an ASEE region conference. The conference committee encouraged the SWE students and advisor to submit their work to the *Transactions on Techniques in STEM Education* journal. As a result, the paper received the **Best Paper Award** in September 2016 (see Figure 3b).

a. b. c.

Figure 3: a. Workshop on Electric Pianos; b. Best Paper Award; c. Workshop on Electric Blowers

Vaughn female students have attended the SWE Annual Conference since 2012. In 2015, it was observed that the conference offers workshops from different universities and colleges. The advisor discussed with SWE students the possibility of organizing a workshop at the conference. In 2016, following a highly competitive application process involving numerous institutions, the SWE-Vaughn Chapter students were selected to host a workshop titled **"Cross-Cultural Immersion Simulation: An Opportunity to Develop Intercultural Collaborative Skills Firsthand"**.

The students designed an interactive simulation in which workshop participants were volunteered to join one of two groups representing different cultural styles: a Western society (open-minded but prone to frequent debate) and an Eastern society (quiet, hardworking, but less verbally communicative). Both groups were tasked with building a small house using same materials. The activity allowed participants to observe differences in efficiency, design, and collaboration during the planning and implementation phases (see Figure 4).

Through post-workshop discussion, attendees recognized that each cultural approach has distinct strengths and limitations. The activity emphasized that effective collaboration requires integrating the advantages of diverse cultural backgrounds while mitigating potential weaknesses. The workshop received a five-star evaluation from participants.

Figure 4: Workshop at 2016 SWE Annual Conference

Subsequently, the SWE-Vaughn Chapter organized several additional workshops, including **"Do's and Don'ts of STEM Outreach"** at the 2017 SWE Annual Conference (Figure 5a and 5b) and **"Stop Being Silly!"** at the 2018 SWE Annual Conference (Figure 5c). At the 2018 SWE Annual Conference, students also conducted a mini hands-on workshop (Figure 6).

a. b. c.

Figure 5: Workshop at 2017 and 20218 SWE Annual Conferences

Figure 6: Hand-on Workshop at 20218 SWE Annual Conference

As mentioned previously, workshops for high school students have been continually held to the present. Since 2020, the SWE-Vaughn Chapter has collaborated with the Robotics Club, the UAV Club and NSBE (National Society of Black Engineers) to host workshops during **Manufacturing Day** in November and **STEM Day** in March each year (Figure 7a). In addition, SWE-Vaughn Chapter students

a. b.

Figure 7: a. Hand-on Workshop with Robotics and UAV Clubs; b. RESUME Workshop with NSBE

often in collaboration with these student organizations, regularly conducts workshops focused on résumé writing and interview skills development (Figure 7b).

These social and professional activities contributed significantly to the development of students' leadership skills and helped them overcome personal and academic challenges. Over ten years of SWE club involvement, clear progress has been observed in students' technical knowledge, professional growth, and leadership capabilities. While many students have participated in SWE activities, this paper highlights the outcomes of nine SWE presidents (one student served two consecutive terms).

Currently, all nine alumni are employed at major companies or studying at prestigious universities, including Toyota Motor Engineering, The Ohio State University, Daimler Truck North America, Honeywell, Lockheed Martin, Jet Propulsion Laboratory (NASA), and the Boeing Company. Their professional roles include Principal Engineer, Mechatronics Engineer, Software Engineer, Advanced System Safety Engineer, and Systems Engineer. Among these alumni, six have earned or are currently pursuing master's degrees, and one has earned a Ph.D. degree. One alumnus is presently studying as a full-time student in Aerospace and Astronautical Engineering at Stanford University and is expected to graduate in Spring 2026.

In follow-up discussions, all alumni reflected that their involvement in SWE-Vaughn Chapter played a critical role in advancing their leadership development and career trajectories.

UNMANNED AERIAL VEHICLE (UAV) CLUB, AIAA STUDENT CHAPTER

Founded in 2014, the Vaughn UAV Club operates under faculty guidance as part of the AIAA Student Chapter. Faculty advisors have structured technical and outreach activities, ensuring students gain both engineering competence and leadership skills. Since its inception, the club's technical and outreach activities have been documented annually by faculty advisors in the College Journal of Engineering and Technology, providing a longitudinal record of competition participation, student engagement, and educational outcomes.

Organizational Timeline and Competitive Achievements

2014–2016: During its formative years, the Vaughn UAV Club developed foundational competencies in multirotor assembly, avionics integration, flight safety, and mission planning. Early projects emphasized manual and semi-autonomous flight operations, establishing the technical groundwork for participation in national student competitions.

2017: The Vaughn UAV Club earned **Second Place** at the 2017 AHS International Micro Air Vehicle (MAV) Student Competition, marking the college's first national-level UAV award, and validating the club's systems engineering approach.

2018: Building on prior experience, the club achieved **First Place** in the remotely piloted MAV category at the 2018 AHS International MAV Student Competition. The winning platform demonstrated improved aerodynamics, refined control strategies, and effective payload integration, establishing the club as a competitive and technically mature organization.

2019–2021: The Vaughn UAV Club expanded its competitive scope through participation in the AUVSI Student Unmanned Aerial Systems (SUAS) Competition, emphasizing fully autonomous navigation, object detection, and mission interoperability. Student teams implemented computer vision, GPS-based navigation, and autonomous mission-planning techniques aligned with industry practices and FAA considerations.

Figure 8: 2018 AHS Int. MAV Student Competition with 1st Place in Remotely Piloted MAV Category

2022 - Present: The Vaughn UAV Club expanded its design experience by participating in the VFS Design–Build - Vertical Flight (DBVF) activities and the AIAA Design/Build/Fly (DBF) Competition. These experiences introduced students to fixed-wing UAV design, fabrication, and flight testing, complementing prior rotary-wing work and strengthening multidisciplinary aerospace design competencies aligned with AIAA educational objectives.

Faculty mentorship guided students through national competitions, emphasizing iterative design, flight planning, and team-based problem-solving. Faculty also advised on **technical documentation, performance analysis, and project strategy**, enabling consecutive national awards and recognition (Figure 8).

Community Outreach and Pre-College STEM Engagement

Beyond competition activities, supported by continued institutional and departmental backing, the Vaughn UAV Club has sustained a strong commitment to community outreach and STEM pipeline development. Its signature initiative is the **Annual College Drone Day** (Figure 9), hosted on campus and organized by the Vaughn UAV Club under the oversight of the faculty club advisor.

Figure 9: Community Outreach: The Vaughn Annual Drone Day for Eight Consecutive Years

This event provides middle school, high school, and community college students with exposure to UAV demonstrations, flight simulations, and hands-on activities, fostering early awareness of aerospace engineering and UAS-related career pathways.

Figure 10: Community Outreach – Tiny Whoops Competition at Cradle of Aviation Museum, Feb. 2020

The Vaughn UAV Club has also collaborated with the Cradle of Aviation Museum to host pre-college UAV events, including the Tiny Whoops drone race for middle and high school students (Figure 10). In these activities, the club students serve as mentors, judges, and technical facilitators, reinforcing their own technical communication skills while supporting regional STEM education initiatives aligned with workforce development priorities identified by AIAA and the FAA.

Student Employment and Career Outcomes

Participation in the Vaughn UAV Club has translated into tangible employment and career outcomes. Alumni have secured internships and full-time positions in aerospace, defense, and UAS-related industries, reflecting the alignment between club activities and industry-relevant skills. Documented placements include organizations such as Lockheed Martin, SpaceX, and Easy Aerial, with roles spanning systems engineering, manufacturing, and UAS integration.

Educational Impact and Assessment

Sustained engagement in the Vaughn UAV Club positively impacts student learning, retention, and professional preparation. Club projects require students to integrate theoretical knowledge in aerodynamics, controls, fluid mechanics, electronics, and manufacturing into operational UAV systems, reinforcing course content through iterative design, testing, and validation.

Assessment data, including faculty observations and longitudinal college journal, indicate that participants demonstrate improved performance in team-based design courses, increased confidence in open-ended problem solving, and stronger alignment with ABET student outcomes related to engineering design, experimentation, teamwork, and technical communication [5]. Engagement in nationally recognized competitions and structured outreach activities further develops professional skills in project management and leadership [6] and [7]. Collectively, these outcomes suggest that faculty involvement ensures **safe, structured, and pedagogically meaningful experiences**, allowing students to mentor pre-college participants, reinforce technical skills, and practice communication and leadership. Alumni outcomes demonstrate that students successfully translated these experiences into internships and careers in aerospace, defense, and UAV industries.

ROBOTICS CLUB

Established in 2011, the Robotics Club has grown under faculty mentorship in both technical and leadership domains. Faculty advisors guided early project and later development, teaching students to build and program mobile robots while emphasizing teamwork and structured problem-solving.

VEX University Robotics World Competitions and Community Outreach

Faculty-directed participation in the VEX University Robotics World Competition has supported technical skill development, iterative design, and strategic planning.

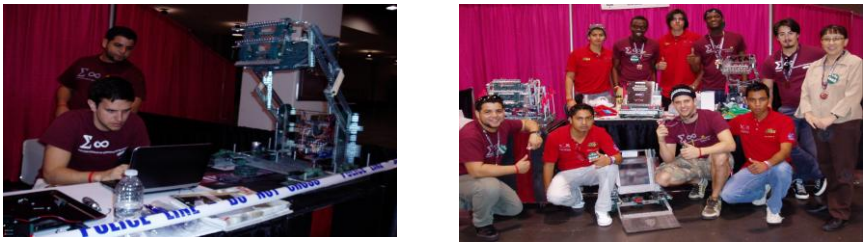

Figure 11: Students Attending 2013 VEX World University Robotics Competition

In **2013**, the college sent four students to participate in the **VEX University Robotics World Competition** (see Figure 11). The team placed **36th out of 60 teams**. The club advisors encouraged the students, noting, "You did well. With continued effort, you can achieve excellence soon." At the same time, the advisors guided the team in developing effective teamwork strategies and in building and programming a differential-drive robot. Additionally, one faculty advisor involved Robotics Club students in outreach programs, where they taught elementary and high school students how to construct and program robots. (Figure 12).

Figure 12: Robotics Club in Summer Outreach Program

The approach of teaching elementary and high school students on robotics with the support of Robotics Club members has proven highly effective. Club students, motivated by their own interest in programming mobile robots, gained valuable insights while mentoring younger students, improving both their design and programming skills. Additionally, serving as "Big Brothers" in this informal learning environment allowed them to practice leadership skills. College students' enthusiasm for learning while teaching often inspires middle/high school students to develop an interest in engineering.

Another experience learned from the development of the Robotics Club, particularly in preparing for competitions, is the value of involving veteran students in leadership roles, at least initially. Vaughn College is well known for welcoming veteran students, who often maintain composure under the intense

pressures of competition. Their discipline and adherence to device maintenance and troubleshooting protocols also set a strong example for newer students, many of whom come directly from high school.

Over the course of a year, club students built and programmed two mobile robots, developing five distinct strategic programs for offensive and defensive scenarios. Responsibilities were clearly assigned, including pre-match robot inspections, post-match evaluations, and replacement of potentially damaged components. After a year of preparation, the team returned to the **2014 VEX University Robotics World Competition** in April, and achieved **Finalist** status (see Figure 13), marking the institution's first recognition at this level.

Figure 13: The Robotics Club at 2014 VEX U Robotics World Competition

However, the road to success was not without challenges. In 2015, while preparing to compete for the championship, the team placed fifth, leaving students frustrated. Club advisors helped them analyze the outcome from both technical and strategic perspectives. Students acknowledged that their eagerness to win had led them to rush preparations, neglecting thorough planning.

Once the issues were identified, a new preparation process began. Since the core team members were seniors, faculty discussed whether students could incorporate the competition robots into their *capstone design projects*, following an approach similar to that in [8]. We consider that capstone projects are intended for students to address real-world problems using classroom knowledge, and the annually changing VEX University Robotics World Competition provides such a practical design challenge. Each year's competition emphasizes different technical requirements, inspiring students to develop innovative solutions. Consequently, for the first time, the college allowed students to select the competition as their capstone project topics.

Senior students were divided into two groups. The capstone project advisor also served as one of the robotics club advisors. One group designed a robot with a **fast ball-shooting function**. The advisor guided them on recording and analyzing launch data while varying parameters such as the rotor speed, friction between the launcher and ball, and push force. Students also measured launch distances with full and half battery power. The second group designed a robot tasked with **carrying a small robot** by the end of the competition, including calculating payload requirements when suspended at a certain height. Both groups successfully completed their designs, while intensive driver training ensured optimal robot performance.

Additionally, the lead advisor of the club arranged them to visit high-level local competitions and enrolled the team in several intensive local contests. Guided by the slogan, *"We will get all available points,"* the team steadily improved. Although they did not achieve all points in a single match at the **2016 VEX U World Competition**, they indeed set a record for the **highest total points achieved**, ultimately winning the **Championship** (see Figure 14).

Figure 14: Robotics Club at 2016 VEX U Robotics World Competition

Since 2016, the lead faculty advisor has implemented various strategies to enrich the Robotics Club team experience. These include sending the team to competitions in Mexico, organizing rigorous and structured training sessions, and facilitating a partnership with the VEX Robotics Foundation (VRF). This partnership has enabled the college to host numerous VEX Robotics Competitions for elementary, middle, and high school students, providing club members with expanded opportunities to develop leadership and communication skills. Additionally, the lead faculty advisor has accompanied the Robotics Club team to the VEX U World Competition annually.

The college has consistently participated in the **VEX University World Competition**, earning a high reputation in the process. In **2022**, the team received the **Excellence Award**, the competition's highest honor (see Figure 15).

Figure 15: The Robotics Club Team at 2022 VEX U Robotics World Competition

Career Outcomes - Student Employment and Assessment

Currently, the core members of the Robotics Club hold positions such as **Senior Engineer, Systems Engineer, and Mechatronics Engineer** at leading companies including **SpaceX, Boeing, Lockheed Martin, ArcBest Technologies**, and others. The club president who led the team to the college's first **VEX World Robotics Championship** now serves as **Vice President of Smart Autonomy Engineering – Vaux** at ArcBest Technologies, a global integrated logistics company with 14,000 employees.

Assessment of student growth comes from faculty observations, longitudinal tracking, and informal reflections, which indicate significant improvements in technical competence, leadership, problem-solving, and professional preparedness. Alumni report that faculty mentorship in the club context directly influenced their career trajectory and leadership skills. Additionally, faculty also facilitated community outreach, including mentoring K-12 students, organizing local competitions, and hosting workshops.

STUDENT ENGAGEMENT AND FACULTY SUPPORT: ASSESSMENT AND DISCUSSION

Across all clubs, faculty mentorship has been central to sustaining student engagement. Faculty provide guidance in project planning, technical problem-solving, leadership, teamwork, and communication. They also help **integrate club activities with the curriculum**, including student research projects and conference presentations.

To assess how the club activities influence students' academic progress and social development, we examined capstone projects completed by students in the two programs – Mechanical Engineering (MEE) and Mechatronic Engineering (MCE), since more than 90% of Robotics, UAV and SWE club participants come from these majors. Students were divided into two sets: (1) students were highly or moderately engaged in club activities (Set#1); (2) students were minimally or not engaged in club activities (Set#2). Their academic performances in capstone projects were evaluated using the grades they received, where A = 4, B+ = 3.5, B = 3, C+ = 2.5, C = 2, D+ = 1.5, D = 1, and F = 0. The average grades for students in the two programs are listed in Table#1.

Table1: Average Capstone Project Grades for Students in MEE and MCE Programs

Average Grade in Capstone Project (0~4 scale, 4 = highs)		Set#1 (Actively Engaged)	Set#2 (Little or not Engaged)
MEE (2017-2025)	Number of Students	33	25
	Average Grade	3.71	3.10
MCE (2014-2025)	Number of Students	82	52
	Average Grade	3.61	3.26

The statistical result in Table1 shows that, in the Mechanical Engineering program, students in Set#1 achieved an average capstone GPA of **3.71 out of 4.00**, whereas students in Set#2 achieved an average GPA of **3.10 out of 4.00**. Similarly, in the Mechatronic Engineering program, students in Set#1 achieved an average capstone GPA of **3.61 out of 4.00**, compared with the GPA of **3.26 out of 4.00** for students in Set#2. The difference suggests that participation in student organizations may contribute positively to capstone performance, likely due to increased opportunities for teamwork, leadership development, and hands-on experiential learning that complement formal engineering education.

Faculty mentorship also ensures continuity over multiple years, supports students through both failures and successes, and facilitates structured community engagement. Longitudinal evidence indicates that students develop confidence, technical expertise, and leadership capabilities while contributing meaningfully to outreach initiatives. This approach demonstrates how faculty can create and sustain **learning communities within and beyond the classroom**, aligning with the goals of community-engaged engineering education.

CONCLUSION

This paper has described faculty-supported extracurricular engineering clubs as effective mechanisms for promoting **student engagement, professional growth, academic success, and community impact**. Faculty mentorship has been essential in sustaining these activities by providing guidance in technical projects, competition preparation, workshops, and outreach events.

Over the past decade, faculty involvement has enabled students to participate in competitions, lead workshops, mentor pre-college students, and present at professional conferences. These experiences have strengthened students' technical skills, leadership, teamwork, and professional readiness. Faculty mentorship has also fostered continuity and sustainability, ensuring long-term student engagement and consistent community outreach. At the same time, the experiences demonstrate that **faculty-supported student organizations can serve as effective models for integrating community engagement into engineering education**. They may offer helpful insights for institutions seeking to enhance experiential learning, leadership development, and reciprocal partnerships with the community.

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