Project Based Learning and Engagement of Multidisciplinary Student Teams in Ocean Renewable Energy Projects

Dr. Saffeer M. Khan P.E., University of North Carolina at Charlotte

Dr. Saffeer M. Khan, graduated with a Ph.D. in Electrical Engineering from University of North Carolina (UNC) at Charlotte. He has served in various academic positions at University of Arkansas Fort Smith and Arkansas Tech University between 2014 – 2022. Presently, he is a Research Associate Professor and manages the Flexible Energy Lab Suite in the Energy Production and Infrastructure Center (EPIC) at UNC Charlotte. Dr. Khan has over 20 years' experience of research and training, project management and engineering, and multidisciplinary collaboration in defense and academia. He is a principal investigator on several ocean renewable energy related projects sponsored by the North Carolina Coastal Studies Institute and focused on wave and wind energy resource characterization and powering the blue economy applications. Dr. Khan was the Principal Investigator on a multi-institutional, two-state, National Science Foundation Type 1 Developmental Regional Innovation Engine project focused on clean energy and grid modernization. Dr. Khan is an active member of the Institute of Electrical and Electronics Engineers (IEEE), and IEEE Power and Energy, Industry Applications, Oceanic Engineering, and Power Electronic Societies. He is also a licensed Professional Engineer (Power) in Arkansas and North Carolina.

Patrick Evan Hultberg, University of North Carolina at Charlotte

Patrick Hultberg graduated from UNC Charlotte with his Bachelors in Computer in Engineering and will be attending Carnegie Mellon University to get his masters in Computer Engineering. He has served as an Undergraduate Research Assistant at UNC Charlotte between 2023 and 2026. He has contributed to various projects including a resource characterization of the wind and wave energy resources off the coast of North Carolina and microgrid fuel efficiency modeling. Patrick Hultberg is also an active IEEE Eta Kappa Nu and is the team co-lead for Duck, Duck, Goose, UNC Charlotte's Marine Energy Collegiate Competition which has been named as the rising star of the competition and has won best poster in the competition.

Michael Alexander Poole, University of North Carolina at Charlotte

Michael Poole is a junior-level undergraduate student in Mechanical Engineering at the University of North Carolina at Charlotte. Michael Poole has been a research assistant underneath Dr. Saffeer Khan for over a year and will continue his assistantship throughout the completion of his Mechanical Engineering degree. Additionally, Michael Poole is a Department of War sponsored SMART Scholar for NAVAIR Flight Readiness Center East.

WIP: Project Based Learning and Engagement of Multidisciplinary Student Teams in Ocean Renewable Energy Projects

Abstract

This work in progress paper will discuss how providing students with the opportunity to display skills they learn is imperative to their learning experience. Connecting engineering problems with emerging industries inspires students to create and accelerate professional practices through friendly competitions. Over the past three years, a cohort of multidisciplinary students at UNC Charlotte have been developing innovations in harnessing marine renewable energy through participation in the Marine Energy Collegiate Competition (MECC) and University Marine Energy Club. Funded by the United States Department of Energy (DOE), MECC provides students with technical design, community connections, build and test, and business plan challenges to develop a wave energy converter (WEC) for their chosen powering the blue economy application. Completion of technical design, build, and test challenges requires students to create innovative WEC designs for power generation and manufacture prototypes to conduct testing and evaluation. In addition to engineering focused problems, students must address the business plan and technoeconomic efficacy of their chosen design. Throughout the competition cycles, the MECC team at UNC Charlotte, composed of undergraduate students, has created three different WEC designs. Through a project-based learning and management approach, students gained invaluable hard and technical skills as well as soft and professional skills that are inaccessible in a typical engineering curriculum. These skills include problem solving, data analysis, software coding, and manufacturing as well as communication, teamwork, creativity, critical thinking, leadership, and project management. The students performed outreach activities in K-12 classrooms and provided ideas and lesson plans for the school systems in two regional counties (Guilford and Mecklenburg). Students also benefited from oral and written presentations of their work at reputed regional, national, and international venues. Through leadership positions, students gained experience as leaders and managers, and learned the importance of responsibility, organization, and collaboration. Over the last three years a multidisciplinary cohort of 35 students with majors in engineering, computing, business and finance, and social sciences has been engaged through the MECC. Qualitative feedback from the students indicates significant skills development in simulation, CAD modeling, and data analysis while adhering to the engineering design process along with gaining insight into business and financial aspects of the projects across various sectors of the blue economy.

Introduction

Through undergraduate academic experience, there are limited opportunities for engineering students to utilize their skills outside of classroom settings. The essential professional skills for the workplace, such as oral presentations and technical writing, are not often the focus of engineering classes [1]. This shortcoming has been partly addressed by encouraging students to participate in extracurricular activities such as membership of student organizations and taking part in sponsored student collegiate competitions. One such example is the Marine Energy Collegiate Competition (MECC). The National Laboratories of the Rockies (NLR) on behalf of the United States Department of Energy (US DOE) organizes the MECC. The main goal of the competition is for students to develop and enhance technical as well as professional skills for meeting the needs of emerging marine energy sector to power blue economy applications [2]. MECC comprises four challenges: (1) the business plan, (2) the community connections, (3) technical design, and (4) build and test [2]. The business plan challenge requires students to develop a business case and workout the economic considerations for the team's wave energy converter (WEC) and its potential deployment to power a blue economy application [2]. The community connections challenge requires teams to develop connections between participants, the industry, and local communities [2]. The technical design and build and test challenges require teams to design a WEC, build a prototype, and conduct laboratory and tank testing to evaluate its performance [2]. The team at UNC Charlotte has been participating in the MECC for the past three years. The team has pursued the competition as a project and has engaged younger students from all disciplines to actively participate and perform to as high a level as possible. This multi-year project has allowed the team to improve the WEC design while growing the number of students participating in the MECC student club as an extracurricular activity to develop their skills. As part of this study, our team surveyed students on their experience of participating in the MECC activities as well as extracurricular events organized by the Ocean Renewable Energy (ORE) student club.

Literature Review

MECC and ORE club expose cross-disciplinary student teams to a different more effective learning environment than in a traditional classroom setting, leading to greater development of professional skills [3]. Part of this development process is directly working with industry mentors nominated to support student teams by the competition organizers at the NLR. Through direct mentorship with industrial representatives working on emerging ORE technologies, students can receive guidance and improve their skills. MECC also enables students to grow leadership and project management skills and exposes them to the business side of engineering [4]. The main thrust of the competition is to develop teamwork skills through multidisciplinary cohort featuring students from a wide range of majors (business, arts and humanities, education, social sciences, computing, and engineering etc.) This leads the students to learn teamwork to a new degree, mimicking a professional work environment where multidisciplinary teamwork and communication is frequent and necessary [5]. In addition to professional skills, design competitions also help undergraduate students prepare for graduate studies through critical thinking skills essential for research and innovation. This readiness comes from an increase in confidence in subjects covered in the design competition, confidence in design related skills, as well as exposure to large conferences, which especially help prepare for graduate studies [1]. These opportunities also allow students to learn technical skills and general knowledge about areas of engineering that traditional education often does not afford. Many students do not fully realize the potential gains from their participation, often due to a lack of diversity within the teams [6].

Traditional classwork within the engineering curriculum often struggles to teach teamwork and leadership. This is of particular concern because skills like those previously mentioned will be what ensures that students stand out with potential employers [7]. A solution to this problem has been presented in the form of the use of extracurricular design competitions such as the Marine Energy Collegiate Competition. In student clubs oriented around design competitions, students take the lead, which leaves room for students to take care of securing funding, deciding on designs, community outreach, and project management. This impacts positively on student learning compared to faculty lead engineering teams [5]. Interdisciplinary teams, with students ranging from different engineering to business students, mimic a real-world engineering scenario closer to what one would see inside a workplace. Furthermore, both technical and soft skills are developed at a higher level than the average student would do without participation. A study conducted by Duke University in the categories of communication, ideation, low-fidelity prototyping, CAD/CAM, electronics, and professional development survey students who had participated in extracurriculars developed these skills at a level above the mean of the entire sample [8]. Engineering in the industry is tightly related to the cost of production or overall profitability, so business and communication students help simulate a business department within a company [9].

Community outreach is a critical part of engineering education and is a key focus of the MECC. When undergraduate students visit K-12 classrooms to present an engineering-based lesson or extended curriculum, both kinds of students learn and grow in a positive way. The K-12 student grows a better understanding of an engineering topic, and the undergraduate students gain more confidence within their skills and knowledge of what they have learned. For instance, the STOMP program from Tufts University surveys conducted on the participating students found that students often enjoyed their experience while developing professional skills such as communication and people skills that would not have otherwise been improved in the classroom [10]. According to a study run by CU Bolder in the 2009, 2010, and 2012 school years, undergraduate students who participated in extracurricular outreach activities highlighted that 85% of the time that they were able to develop stronger oral communication skills as a result of their participation in these programs [10]. The K-12 students have shown a higher interest in enrolling in engineering, and both have shown a higher retention rate in an engineering field of study [11]. The previously mentioned study also highlighted that K-12 students who interacted with these clubs would be more likely to develop an interest in engineering [11].

Approach to the Ocean Renewable Energy Project

The UNC Charlotte team has been competing in the MECC for three competition cycles and has participated in the previously mentioned challenges. During the first year, the team comprised mostly of cross-disciplinary sophomore students. They designed and built a simple WEC with a potential application to collocate it with offshore wind farms along the coast of North Carolina as a way for the team to gain an understanding of the competition and its structure. The following cycle, the team developed first iteration of the WEC intended for seawater mining. The team improved the design by implementing a direct drive linear permanent magnet generator-based system (LPMG). This design was chosen due to its minimal maintenance costs, as well as higher reliability and lifespan— which offers a significant advantage over traditional hydraulic or geared WECs. The direct drive system enables the team to use a combination of a higher density of poles to increase the magnetic flux with power electronic systems to increase the generator output. This eliminated the need for high-wear mechanical power transmission, allowing a longer service life. The system used a core (stator), and a coil (translator) fixed to an inner and outer buoy, respectively. The inner buoy was fully submerged and fixed to a mass as well as a drag plate, to ensure the core remains stationary under wave conditions. The outer (ring) buoy responded to incident waves and behaved as a spring-mass-damper system or harmonic oscillator due to hydrodynamic effects. This allowed the ring buoy frequency to be optimized for different useful wave periods to target maximum energy production under predictable conditions. Figs. 1-3 show the fully designed system.

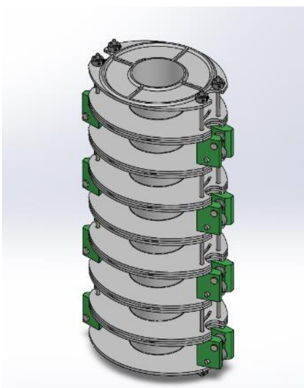

Figure 1: Coil Stack

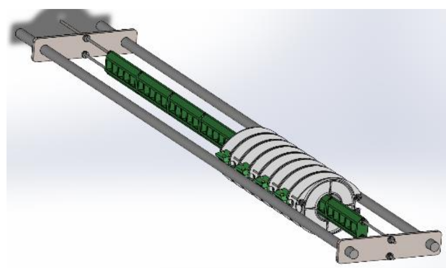

Figure 2: LPMG Assembly

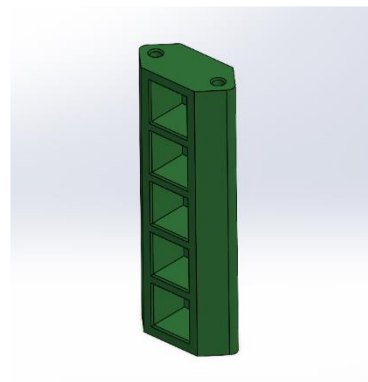

Figure 3: Core Segment

Within the multibody system, there was the custom built LPMG connected to the system to convert the generated AC to DC before processing that signal as an input to the electrolysis device for hydrogen electrolysis as shown in Fig. 4. That system consisted of a simple diode rectifier to convert the low frequency AC to DC filtered with a battery storage system. The power was transmitted to an onshore facility where it was passed through a buck converter to step up the frequency (which allowed for a cheaper filter to be used to clean up the signal's ripple voltage so that it was within the tolerance needed to effectively perform electrolysis). Following the completion of wave tank testing and the 2025 competition finals, the team considered improvements in the design as the generator performance was below expectations. The power take-off system worked as intended mechanically achieving the designed resonance frequency; however, the generator's power output was sub-par.

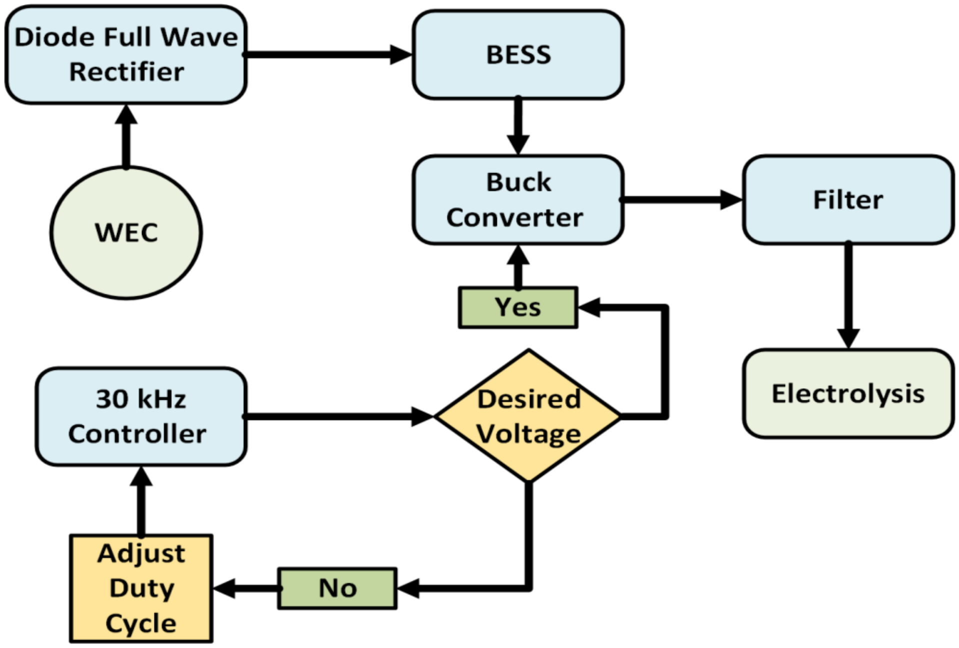

Figure 4: Electrical system interconnections

The team is using the current competition cycle to improve the generator design by utilizing multiple coils arranged in a cylindrical fashion while maintaining the LPMG approach. The redesigning of 3D printed parts optimized the generator core which was previously not ideal for conducting the flux from the permanent magnets in the Power Takeoff (PTO) stage. The team has added steel coated in epoxy to prevent the generation of eddy currents to the core and direct the magnetic flux from the core to the center of the coil. The coil body is also redesigned into multiple smaller coils, each of which are contained within an E shaped structure ensuring that maximum flux links to the coil.

In addition to the technical thrust of the competition, the team also had to develop a business plan. As previously mentioned, the team during the last competition cycle decided to design a system for hydrogen electrolysis. For the current cycle, the team has shifted its focus to provide power to microgrids for remote coastal communities. Students from business and finance majors are working on the technoeconomic aspects of the design especially in terms of computing the levelized cost of energy (LCOE) as well as potential for scaling up of the WEC design with potential for future commercialization.

The final thrust of the competition required the team to engage local communities and increase awareness of ORE technologies, especially the WECs. The team visited K-12 schools in local counties and conducted lessons in the classrooms and engineering camps. These lessons were also hosted by the team's affiliated institution as well as presentations to the policy makers, industry representatives, government officials, and broader student community on campus. The activities included an engineering camp, lessons at middle and high schools, and engaging with prospective students at open houses hosted by the institution. The team used wind turbine kits, WEC models, and electronic circuit design to demonstrate power conversion. The team also developed a wave energy lesson which has been adopted by K-12 districts in two regional county school systems. The lesson tasked students with developing a floating element of a WEC which would be used to hold magnets inside a coil to generate an AC signal. The K-12 students would compete to see who could generate the most AC voltage with the lightest element. The team also engaged industry professionals at the annual North Carolina Renewable Ocean Energy Program (NCROEP) Symposium. This enabled students to get feedback from industry professionals and incorporate it into their design. For the 2026 competition, the team has continued to participate in these activities and with other student organizations at UNC Charlotte and NCROEP Symposium. The team has built a strong relationship with the Energy Production and Infrastructure Center at UNC Charlotte and the Coastal Studies Institute (CSI), which enables them to use the lab facilities and water tank for testing the WEC design. The important regional connections have helped the team build strong industry partnerships and community outreach.

Utilizing the multidisciplinary cohort of students involved in the student organization has allowed the team to become a unique participant in the competition. Since the entire student organization is comprised of undergraduate students, the projects are organized, manufactured, and completed by them. While some teams in the competition involve professor-led or graduate student-led research projects or senior design projects, the team at UNC Charlotte has differed from this approach. Our student-led approach has encouraged undergraduate students, new to the field of engineering, to become leaders for their team in competition and develop engineering design experience. With additional educational support from the EPIC, students accelerate their learning and are prepared to understand and communicate the impact of their developed WEC.

Each of the MECC challenges has objectives that must be achieved by the participating teams during the competition. Table I shows the objectives for all aspects of the competition [12].

1. **Technical Design:** (1) Clear design objective description, (2) Power performance analysis, (3) Electromechanical testing with relevant safety factors, (4) Clear description of system optimization, (5) High quality technical diagrams, (6) Consideration for relevant environmental and sustainability factors, (7) Consideration of end user needs, and (8) Displaying clear educational development during the design process.
2. **Build and Test:** (1) Create scaling factors to be considered when designing a full-scale design, (2) Test plan that permits relevant data collection, (3) Successful execution of the test plan, and (4) Lessons learned during testing and proposed improvements.
3. **Community Connections:** (1) Produce a high-quality after-action report, (2) Produce a set of metrics pertaining to their activities, (3) Conduct analysis of the metrics, and (4) display the benefit of their outreach.
4. **Business:** (1) Display the market feasibility of the device, (2) Evaluate risks, (3) Highlight novelty of their approach, (4) Conduct end user interviews and conduct stake holder engagement, (5) Conduct an accurate financial analysis, (6) Show growth while developing a business plan.

These objectives have a clear link to the Accreditation Board for Engineering and Technology (ABET) student learning outcomes (SLOs). Specifically, the following SLOs are in line with the MECC objectives [13]:

1. Students will develop an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Students will develop an ability to apply engineering design that meets specified needs with the public's consideration.
3. Students will develop the ability to communicate effectively with a wide range of audiences.
4. Students will develop an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Students will develop an ability to function effectively in a team whose members will provide leadership and create a collaborative and inclusive environment.
6. Students will develop an ability to create and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgments to draw conclusions.
7. Students will develop an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

In particular, the student outcome objectives 1, 2, and 5 match objectives 1, 6, and 7 in the technical design challenge and objectives 2, 3, and 4 in the build and test challenge. The team is required to determine a clear use case in the blue economy for the device that the team develops. These use cases can include aquaculture, seawater mining, desalination, resiliency and disaster recovery, and isolated power systems [14]. Once the use case is selected, the team must consider the environmental and sustainable factors of the use case and the needs of the end users as seen in objectives 6 and 7 in the technical design challenge. These two objectives are in line with SLO 2 because these teams are required to consider the environmental ramifications of their design and the needs of the targeted users. SLO 5 aligns with objectives 2, 3, and 4 in the build and test challenge because the team must develop a testing plan for their device, conduct the testing, and analyze the collected data. Finally, SLO 1 is linked with objective 1 in the technical design challenge as the team is required to identify an engineering problem and propose a solution. SLO 3 is linked with the community connection challenge and requires engaging a wide range of audiences. Table II highlights the breakdown of SLOs to corresponding MECC objectives.

Table II: MECC Challenge Objectives and the Corresponding ABET SLOs

Rubric	Business Plan	Community Connections	Technical Design	Build and test
1	1, 2	3	1	2
2	4	3	6	6
3	n/a	3	6	3, 6
4	4, 5	3	2, 5, 6	6

5	6		3	7
6	7		2, 4	
7			2	
8			7	

Survey Design

The team developed a survey instrument and shared it with current and former students who participated in the MECC team at UNC Charlotte and engaged in the extracurricular events organized by the ORE club. Appendix A includes the survey questions comprising eighteen statements that can be rated on an 11-point Likert scale (zero to ten with a zero meaning strongly disagree and a ten meaning strongly agree). A select group from the sample was asked to provide qualitative feedback on their experience as students while participating in the project.

The team collected the data by devising a series of questions that are in line with the SLOs. Specifically, this study focuses on the development of students' communication skills, technical design skills, leadership skills, data analysis skills, and their ability to analyze and interpret data collected from a real world setting among other skills. The study is also intended to prove a strong positive correlation between participation in extracurricular engineering competitions and the development of their professional and academic skills. The survey component of this study was broken down into three specific parts: a demographic portion, a student development portion, and a student testimonial portion. The demographic portion of the survey was four questions that collected data on the students: age, educational background, GPA, and their preferred learning style. The student development portion was eighteen questions that were developed in the form of an 11-level Likert questionnaire that was designed to evaluate skill development. The scale was set from zero to ten with zero meaning strongly disagree and ten meaning strongly agree with the statement that was presented to the responder. Finally, the survey also had a three-question testimonial section in which selected students (who had been with the team from the beginning or were heavily involved in its activities up to this point) were asked to further articulate how their development was impacted by involvement with the MECC team and ORE Club. This portion of the survey gave qualitative data to go with the already quantitative data collected through the student development portion of the survey.

The survey was sent to a total of 58 students of which 20 responded, which makes up the sample utilized in this study. Of the 58 students, 11 students were selected to provide qualitative feedback, five responded, all of which also responded to the survey. Each participant was required to fill out the demographic questions. The demographic makeup of this sample is given in Table II.

Table II: Demographic makeup of the survey sample (N=20)

Age		Years in College		GPA Range		Preferred Learning Style	
<18	0	0-1	3	3.0-3.2	1	Written material	0

18-20	8	1-2	5	3.2-3.4	3	Visual media	2
20-22	10	2-3	4	3.4-3.6	6	Hands on activities	5
22-24	2	3-4	7	3.6-3.8	4	Collaborative Group work	1
>24	0	>4	1	3.8-4.0	6	Mixed Method	12

Data Analysis

Understanding how participation has impacted the development of students who have participated in the team is crucial to this study. The impact of participation was considered by breaking down the questions into five skill groups that correlate to the seven SLOs and averaging the responses to the questions within this group. The skills evaluated are as follows: (1) leadership skills, (2) communication skills, (3) application of technical knowledge to real world problems, (4) technical design skills, and (5) data analysis skills. The mean scores of these are displayed in Fig. 5.

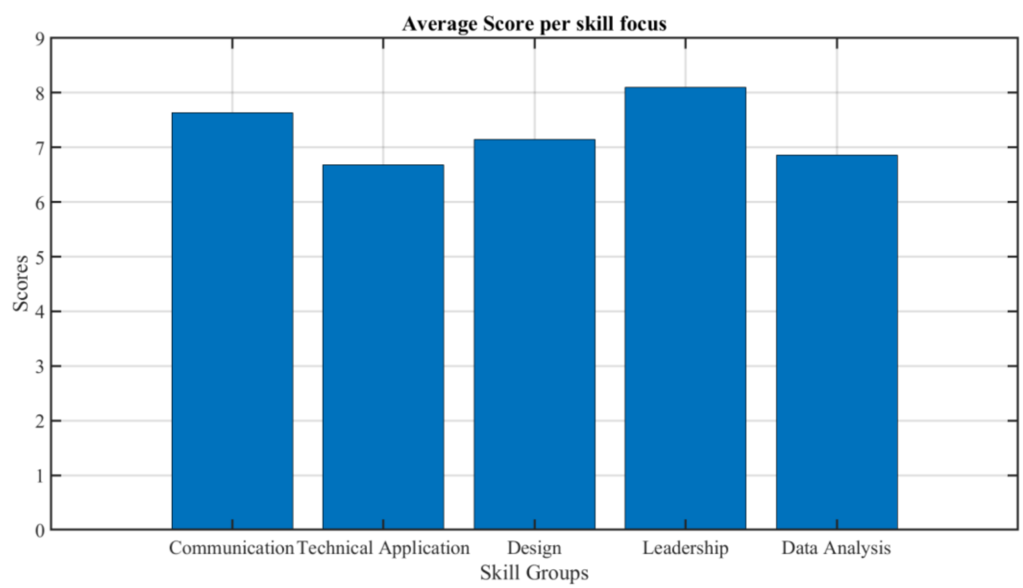

Figure 5: Average score for each skill group considered within the study.

The data highlights the team has done well in developing these skills overall but specifically the team did very well in leadership and communication skills. On average, the respondents gave a score ranging from 6.68 to 8.1 out of 10 with the two skills scoring an 8.1 and a 7.64 out of 10, respectively. These numbers highlight that the project activities have helped the students develop these skills to meet the SLOs. The full breakdown in terms of the average scores per question as well as the frequency of the scores are in Figs 6 and 7.

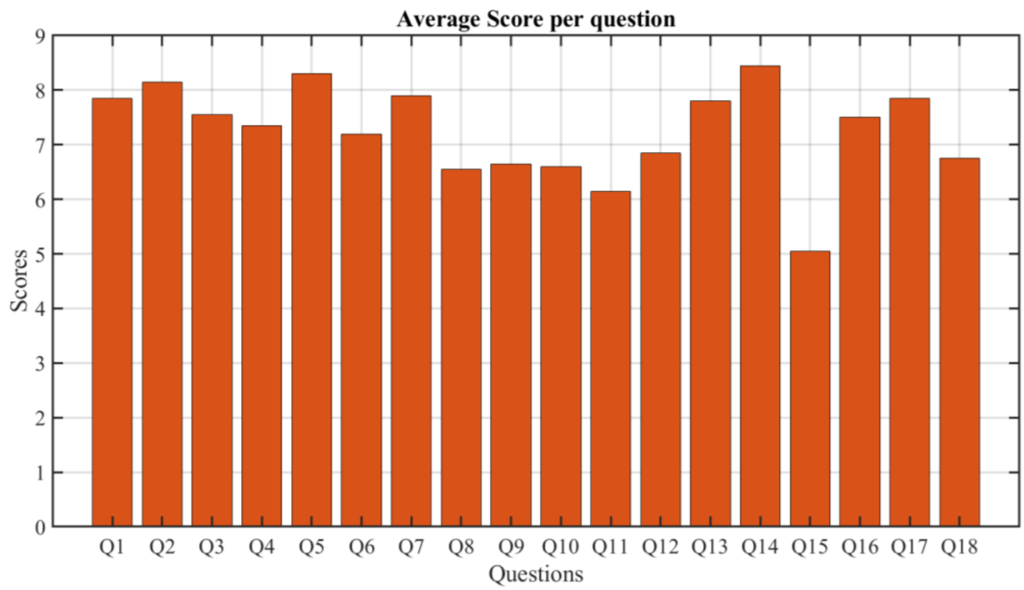

Figure 6: Average scores per question

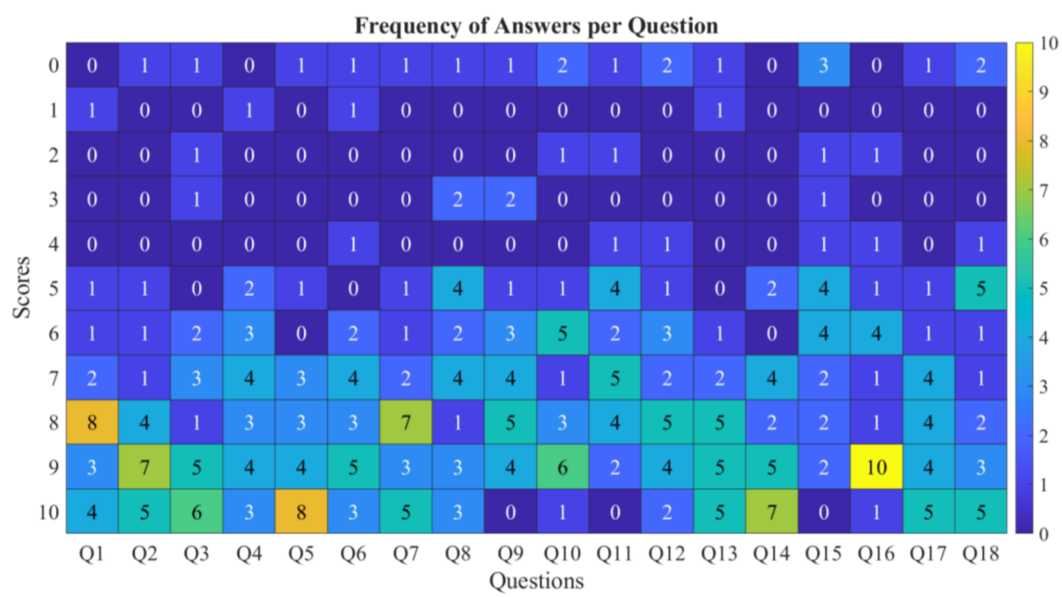

Figure 7: Frequency of score per question

The data highlights that students overall felt that the MECC impacted positively on skill development in the five areas. There is also a clear trend, with Question 15 being on average the lowest scored question. This has created an outlier within the data which has reduced the average score of the technical application score. The removal of outliers would improve the skill score from 6.68 to 7.5. Question 15, as seen in Appendix A, discusses the implementation of software in the design process, which was indicated as a weakness. The MECC team addressed this aspect in the project's current and future iterations. The question that proved to have the highest average score was Question 14 with an average score of 8.45 out of 10. Question 14 focuses on communicating marine energy to unfamiliar audiences and corresponds to the effectiveness of communication skills groups. The student response scores highlight the strong impact of MECC team activities on developing communication skills. The efforts to improve students' communication skills will remain a priority for the team and ORE club in the future as well.

The team used the survey to collect qualitative feedback by asking three open-ended questions to a subset of the sample respondents who had been heavily involved in the team or had been a founding member of the team. The three questions focused on how much students enjoyed their participation and what soft and technical skills they developed while participating in the competition. One student highlighted their development of communication skills "Through several presentations in front of industry professionals, I have developed strong presentation and conversational skills". The same student also highlighted their development of leadership by stating that "as a leader in the club associated with MECC I have had the pleasure of presenting concepts and design progress to an audience with varying technical backgrounds". Another student highlighted that participation in this competition enabled them to "work on several technical analysis skills such as MATLAB and [Finite Element Analysis". These skills were developed "using both SolidWorks and FEMM for doing either structural analysis or electro machinery design". The software tools were used to design the custom-built generator mentioned previously. One student highlighted that "it's been a great experience for me. Going from being a freshman in a bunch of clubs to then a sophomore starting this club, I was really excited for the opportunity. Now as a graduating senior and participating in this competition gave me a place to grow as a student, an engineer, and a person".

Conclusion

This study focuses on the impact of MECC on the development of technical and professional skills in a diverse multidisciplinary student team. The study has highlighted how students have pursued the competition with a unique approach that has utilized leadership roles and the focus of the project to enhance the development of both soft skills like communication as well as technical skills such as engineering modeling and design. A student articulated a more specific example of developing finite element analysis skills when designing electrical machinery. Overall, the average scores of the clusters were between 6 and 8 which highlights a high positive correlation between the participation in the MECC team and achieving the SLOs in ways they would not have received just by attending lectures in class. The program proved to be an excellent milestone to develop communication and leadership skills which were on average the skills that proved to have the most development. This was enhanced by the fact that the question that on average received the highest score included explanation of marine energy concepts to audiences who would not have been familiar with marine energy such as K-12 students. The study found that the area that requires the most improvement was in the development of software skills. In particular, the need to facilitate growth in the use of programming when developing or using tools that aid in the design process as seen by the responses to Question 15. As the current paper is work in progress, the team will pursue the project as a longitudinal study. Going forward, the team plans to collect data at the beginning when participants join the MECC team or ORE club and at the end of competition (or when students leave the MECC team or graduate). This will enable the team to observe the skill development more accurately over the entirety of participation in the MECC or the ORE Club.

References

[1] S. F. Kiefer and C. W. Somerton, "Benefits of Mentoring Students in Design Competitions," in *2011 ASEE Annual Conference & Exposition: June 26-29, 2011, Vancouver, B.C., Canada*, 2011, p. 22.278.1-22.278.9

[2] Author, Corporate. "2026 MECC Overview Slides." Crowdsourcing Platform and Innovator Network, 2025. https://www.herox.com/marine-energy-collegiate-competition/resource/2326.

[3] B. Frank, *Developing Multi Discipline Design Skills in Undergraduates*. 2004, p. 9.415.1-9.415.10. doi: 10.18260/1-2--14117.

[4] B. Ogwezi, K. Tyler, N. Manai, and C. Penny, *Closing the gap between industry and academia via student team's support*. 2023. doi: 10.18260/1-2--43215.

[5] S. Bellinger and C. Hochgraf, *Using national competitions to focus student clubs*. 2010, p. 15.1332.1-15.1332.8. Doi: 10.18260/1-2--16454.

[6] S. Walden, C. Foor, R. Pan, R. Shehab, and D. Trytten, *Leadership, Management, and Diversity: Missed Opportunities Within Student Design Competition Teams*. 2015, p. 26.1059.1-26.1059.23. Doi: 10.18260/p.24396.

[7] L. J. SHUMAN, M. BESTERFIELD-S ACRE, and J. MCGOURTY, The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed? http://onlinelibrary.wiley.com/doi/10.1002/j.2168-9830.2005.tb00828.x/pdf (accessed Apr. 27, 2026).

[8] K. Drinkwater, K. Boyd-Sinkler, and R. Simmons, "ASEE peer - why should you join? exploring the role of engineering clubs on the Undergraduate Engineering Experience," Why Should You Join? Exploring the Role of Engineering Clubs on the Undergraduate Engineering Experience, https://peer.asee.org/why-should-you-join-exploring-the-role-of-engineering-clubs-on-the-undergraduate-engineering-experience (accessed Apr. 27, 2026).

[9] D. Bayless, *Engineering Leadership Development using an Interdisciplinary Competition-based Approach*. 2017. Doi: 10.18260/1-2--28256.

[10] J. L. Yowell, M. S. Zarske, D. Knight, and J. F. Sullivan, "Impact of teams clubs: An afterschool engineering ...," Impact of TEAMS Clubs: An Afterschool Engineering Enrichment Program that Impacts K-12 Students and College Student Leaders, https://peer.asee.org/impact-of-teams-clubs-an-afterschool-engineering-enrichment-program-that-impacts-k-12-students-and-college-student-leaders.pdf (accessed Apr. 27, 2026).

[11] M. Portsmore, K. Conroy, M. Pickering, E. Ryan, and B. Gravel, *The Benefit of Outreach to Engineering Students*. 2004, p. 9.1235.1-9.1235.12.

[12] C. Author, "Marine Energy Collegiate Competition (MECC)," Marine Energy Collegiate Competition Official Rules, https://americanmadechallenges.org/challenges/marine-energy-collegiate-competition/docs/Marine-Energy-Collegiate-Competition-Rules.pdf

[13] C. Author, "CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS Effective for Reviews during the 2025-2026 Accreditation Cycle Incorporates all changes

approved by the ABET Board of Delegates Engineering Area Delegation as of October 25, 2024," ABET, 2024.
[14] LiVecchi, A., A. Copping, D. Jenne, A. Gorton, R. Preus, G. Gill, R. Robichaud, R. Green, S. Geerlofs, S. Gore, D. Hume, W. McShane, C. Schmaus, H. Spence. 2019. Powering the Blue Economy; Exploring Opportunities for Marine Renewable Energy in Maritime Markets. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, D.C

Appendix A: Survey utilized in the study

Table I: Demographic questions in survey

Question Number	Questions
1	Age Range
2	Years in college
3	GPA Range
4	Preferred Learning Style

Table II: Quantitative Response Questions in the Survey

Question Number	Skills Focused	Questions
1	Communication	I have developed strong oral and written communication skills while working on multidisciplinary marine energy projects.
2	Technical Application	I can apply technical knowledge from the coursework in multidisciplinary marine energy projects.
3	Technical Design	I can apply theoretical concepts to design and develop novel marine energy device.
4	Communication	I can effectively communicate the business, outreach, and technical aspects of marine energy projects.
5	Leadership	I developed leadership skills while working on multidisciplinary marine energy projects.
6	Data Analysis	I can conduct thorough analysis on the feasibility of a proposed marine energy device.
7	Leadership	I have developed strong project management skills.
8	Technical Design	I can design marine energy devices and manufacture a prototype system.
9	Technical Design	I have learned skills necessary to ensure that marine energy devices meet the acceptable specifications.
10	Data Analysis	I have learned to apply data analysis during the design of a marine energy device.

11	Data Analysis	I can develop a mathematical model of a marine energy device.
12	Technical Application	I can develop test methods to check if a marine energy device prototype meets required specifications.
13	Communication	I can effectively communicate with my peers and industry members about my experience working on a marine energy device.
14	Communication	I can effectively communicate concepts of marine energy to K-12 students or those unfamiliar with marine energy.
15	Technical Application	I can develop software programs to design and develop marine energy device.
16	Data Analysis	I can effectively use numerical computation and model-based design tools.
17	Technical Design	My ability to develop a project from start to finish has been enhanced because of my participation in the marine energy competition.
18	Communication	Presenting at competition events has given me confidence in conducting technical or business presentations.

Table III: Qualitative response questions in the survey

Question Number	Question
1	What has been your overall impression of your experience participating in the Marine Energy Collegiate Competition.
2	Do you feel as though participation in the Marine Energy Collegiate Competition has allowed you to develop professional soft skills (presentation skills, leadership skills etc.). If so, please list these skills and how you developed those skills.
3	Do you feel as though participation in the Marine Energy Collegiate Competition has allowed you to develop technical analysis skills? If so, please list these skills and describe how you developed those skills.