

Enhancing Engineering Learning with Classroom Debates on Sustainability and Energy Topics

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Abstract

Sustainability and energy related topics for engineering students require a clear understanding of both fundamental concepts and theoretical analyses. While engineering students may have a strong grasp on both avenues, their verbal communication skills on such topics may need improvement. This paper is about implementing debate sessions into a senior level course named Alternative Energy Systems to address the improvement of verbal communication for engineering students. The implementation has not only enhanced the students' soft skills on technical communication but also has increased the interest in energy topics, including renewable energy and sustainability. The debate sessions require students to conduct research on both their assigned topic they are to advocate for, and the opponent's topic that they are to debate against. Such preparation involves studying the strengths and weaknesses of competing topics, their theoretical and technical limitations, economic analyses, and environmental impacts. The debate sessions have been conducted in a tournament structure where the qualifying teams have progressed to the next level, gradually yielding a final debate session between the two finalist debate teams. Such structure has been enjoyed by the students, which was noted as another benefit of this class activity. In the paper, observations including challenges, benefits, and outcomes on the debate sessions will be discussed with examples from past semesters.

Introduction

Engineering education is expected to improve the students' hard and soft skills, rather than focusing only on hard skills such as mathematics and physics. Soft skills including written and oral communication play a significant role in helping them get better jobs and climbing up the ladder in their career whether it is in private sector or in academia. A noteworthy fraction of engineering students feels that being good at sciences pertinent with their field and having a good grade point average is sufficient in getting a desired job. While this may be true in some circumstances, more than seldom, communication skills are a strong factor towards their success. Debating is a great tool to improve communication skills for engineering students. Students participating in debate clubs in high school experience the benefits of such skills earlier in their lives, during their college years. The research conducted for preparing for the debate not only enhances the student learning on the topic, but also allows them to improve their decision-making skills. Being on the clock while having to advocate an opinion and contradicting the opposing side's opinion on an engineering topic is a useful exercise for students. Some of the skills that benefit from debate sessions include oral communication, timing, decision-making, handling pressure, logical thinking, and taking strategic actions.

There are numerous studies in literature focusing on debates in education for a wide spectrum of disciplines including engineering. Kennedy [1] investigated the impact of classroom debates on students. They were asked to rate their knowledge on the selected topics and to identify their stance before and after multiple debates in the class. It was observed that between 31% to 58% of the students changed their opinion on the selected topics after watching the debates. After the completion of all debates, students were asked if they would consider instrumenting debates as an instructional strategy; 85% of the responses were positive. Fallahi and Haney [2] studied the practicality of using classroom debates in discussing controversial topics. The method was compared to the traditional form of open discussions. According to the students' responses, they found classroom debates to be easier than conventional open discussions when conversing about controversial topics. Omelicheva and Avdeyeva [3] explored the effectiveness

comparison of traditional versus active learning methods. An experimental study on a class was performed to analyze the immediate effects of classroom debates on student learning and to compare the effect of these debates on students' higher order cognitive skills to traditional lecture approach. Chen and Swan [4] investigated the efficacy of online debate sessions. They conducted a study on a group of 52 students consisting of both online enrolled and face-to-face enrolled students. Statistical analysis using Welch's t-test was employed. The responses from the students showed that there was no statistical difference between online and on-campus groups with the survey focusing on several criteria including active learning, critical thinking, interaction and engagement, and Google docs' usefulness for collaboration. Hamouda and Tarlochan [5] utilized the debate sessions in an engineering course. It was observed that the pedagogy approached in the course enhanced student interest and learning. According to another study done by Alaswad and Junaid [6], a successfully integrated debate as a learning tool can improve student learning, critical thinking, communication and teamwork skills, and self-confidence. Chang and Cho [7] explored strategies in selecting the debate topics in engineering education. It was stated that the topics selected should be controversial. Non-controversial topics are stated to be not suitable for classroom debates. The steps listed in determining an effective debate topic include setting educational objectives, analyzing the characteristics of the students, exploring contents, and then searching for research topics.

The objective of this paper is to share the experience of implementation of debate sessions in an energy course that covers different conventional and renewable energy technologies. Topic selection, structure of the debates, debate sessions, final debate reports, scoring, and observed outcomes of implementing this tool in an engineering course are presented in the following sections to shed light on an example of a captivating class activity.

Topic Selection, Debate Structure, Report, and Scoring

Topic Selection

Topics are selected based on the chapters to be discussed throughout the semester. Controversial topics or technologies are picked so that the debate teams can prepare for the strengths of the topics that they will advocate for and the weaknesses of the opposing idea.

Debate Structure

The debates are structured considering the enrollment, hence the total number of teams in class and the lecture duration. Debate series are formed based on the number of teams built and the duration for one lecture meeting. For a 75-minute lecture time, two debate sessions, each of which are 26 minutes long, can be fit in adequately, giving enough settling time before and in between the debates. Each team consists of three students. The structure of the debate is such that the debate opens with one team (Team A) presenting their arguments, followed by a member of the opposing team (Team B). This is repeated for the second speaker in each team. Then, each team gets an opportunity for rebutting the arguments of the other team by their third speaker. Finally, the closing statements are expressed by one of the team members in both teams. Time for each step is given below:

- The first speaker on Team A presents arguments in support of their idea, and possibly asks questions to the opposing team (4 minutes)
- The first speaker on Team B presents arguments in support of their idea, and possibly asks questions to the opposing team (4 minutes)
- The second speaker on Team A presents further arguments in support of their idea, points out any fields of conflict, and answers questions that might have been asked by Team B (4 minutes)
- The second speaker on Team B presents further arguments in support of their idea, points out any fields of conflict, and answers questions that might have been asked by Team A (4 minutes)
- Rebuttal of Team A by the third speaker (2 minutes)
- Rebuttal of Team B by the third speaker (2 minutes)

- Closing statement of Team A by a select member on team (3 minutes)
- Closing statement of Team B by a select member on team (3 minutes)

The debate teams, topic selections, and matching of the teams are all done utilizing an online wheel of fortune. The selections are made in the classroom using this online tool which makes the process enjoyable for the students. It also ensures the fairness of the process from the very beginning. A sample debate tournament schedule is illustrated in Figure 1. The schematic shows the schedule of debates amongst the teams (given in number of each team) from the first round to the final debate.

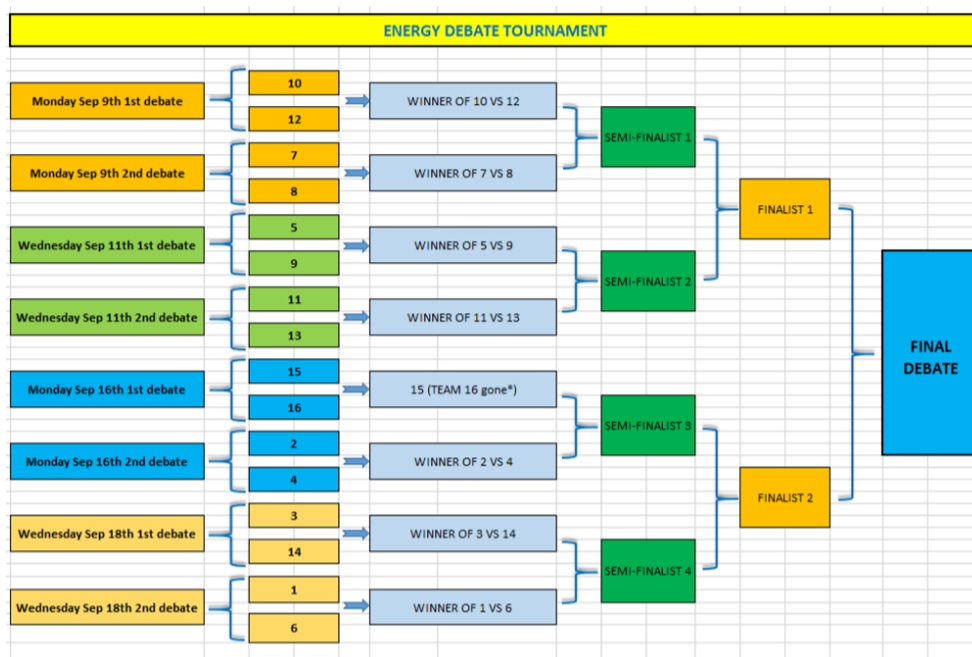


Fig. 1. Structure of the debate competition.

Report

A formal debate report is to be submitted by each team about the topic that the team is advocating for. The report consists of these sections:

- Cover page: Topic that is advocated for, names of the team members, name of the institution, and the date the report is submitted
- Introduction: General information and literature review on the energy source that the team is advocating for
- Strengths of the defended idea: In bullets, list the strengths of the energy source you are advocating for
- Weaknesses of the opponent's idea: In bullets, list the weaknesses of the energy source your opponent is advocating for
- Conclusion: Explain what your observations are, and briefly state why you think your topic is superior to the opponent team's topic
- References: Indicate the sources of information that were utilized in the debate research

Scoring

The scoring of the debate session is performed based on four criteria:

- Speaking and delivery (4 pts)
- Listing strengths of own idea (3 pts)
- Listing weaknesses of opponent's idea (3 pts)
- Timing (2 pts)

These all together add up to 12 points for the debate performance. The debate report which is submitted following the debate session is worth 8 points, hence bringing the total debate score to 20 points. Scoring of the debate sessions can be seen in Table 1. The finalist teams get a bonus of two points. Those who could not make it to the final debate

are given the option of presenting a poster on the final debate day. The poster presenters get a bonus of 1 pt. Both the finalists and the poster presenters engage with the judges and the guests from the engineering society during the networking hour, giving them a chance to expose themselves to the professional world.

Table 1. Scoring of debate sessions.

	Team Members	Speaking and Delivery (4 pts)	Listing Own Idea's Strengths (3 pts)	Listing Opponent Idea's Weaknesses (3 pts)	Timing (2 pts)	Debate Performance Total (12 pts)	Debate Report (8 pts)	TOTAL SCORE (20 pts)
Solar vs. Wind								
Biomass vs. Geothermal								
Nuclear vs. Hydropower								
Geothermal vs. Solar								
Wind vs. Nuclear								
Biomass vs. Hydropower								

Debate Sessions

All debates except the final debate are conducted in the classroom. On each debate day, two debates are performed. The teams participating in the debates submit a debate report by the end of the day the debate is conducted.

Final debate is organized towards the end of the semester. This is a greater-scale event compared to regular classroom debates. Weeks before the final, judges from the energy sector are invited to this event. Engineers from relevant fields along with faculty, students, and community members are also invited. The final debates take place in larger places such as a theatre hall. Outside the hall, students who did not make it to the final present their posters to the guests. After the final debate, all students and guests meet outside by the posters to engage with each other. This is also the networking session for the senior year energy students.

Conclusion

The debates seemed to have improved the overall performance of the classroom compared to students in other semesters who did not have the debate session. It was also observed that the debates increased the interest of the students on the energy topics covered throughout the semester. Some students decided to choose the energy field as their future career and got jobs in the energy sector after graduation. A number of these students have reported that they were fortunate to make connections with energy professionals at the poster and networking session following the final debate event of the semester. Overall, implementation of debate sessions in the energy systems course has captivated the engineering students, resulting in enhanced interest, academic performance in the class, self-confidence in public speaking, critical thinking, logical assessment, and decision-making.

References

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Biography

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