

# DEBATE AS A TOOL IN ENGINEERING AND SUSTAINABILITY EDUCATION

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## ABSTRACT

Debate is an active education tool which is widely used to teach undergraduate students in social science and humanities courses, but less common in Engineering and Computing courses. Debate, in this context, refers to the establishment of contradictory positions on a topic or question and inviting students to form 'teams' or parties each tasked with the responsibility of promoting those positions to an audience through mediated oral discourse. A well-integrated debate can help students to improve their understanding of the subject, improve their critical thinking, increase the retention of the information gained, enhance communication and teamwork skills, promote their confidence and help them to better construct their ideas and thoughts in a logical and sound structure. It is well known that integrating this approach in an active learning environment will promote a student's engagement and motivation to learn. In this paper, the practice of integrating the debate on the climate change response pathways (Adaptation, Mitigation and Geoengineering) in a final year course taken by Mechanical Engineering students will be presented. The effect of using this practice on students' engagement, module feedback and marks will be highlighted.

## KEYWORDS

Debate, Sustainability education, Active learning, CDIO Standards: 1, 2, 3, 11

## INTRODUCTION

Compared with traditional didactic teaching, it is accepted that active learning strategies produce increased content knowledge, greater enthusiasm for learning, development of critical creative thinking skills, and an improve in students' engagement with the topic taught. Several active learning strategies are popular in engineering disciplines such as real-world problem solving, group projects, student presentations and peer response polling systems. The use of debate as a mode of active learning mode was found to be far less popular in engineering courses when compared with other disciplines such as humanities and social sciences.

Debate is regarded as an educational tool to systemise discussion between students on specific topic or question, where teams with contradictory positions on that topic will attempt to make the audience accept their position. A well-planned and integrated debate can help students to increase their understanding of the subject, improve their confidence, communication and team-working skills, enhance their reflection and critical thinking practice,

and learn how to construct their ideas and thoughts in a sound and logical structure. Furthermore, it will lead to increased student retention of the information learned, as it is interest-based learning that engages the mind thoroughly.

In this paper debate as an education tool will be described, mentioning its benefits and drawbacks when applied to different subject areas. A brief literature review will be used to investigate its impact on different educational metrics such as attendance, engagement, knowledge depth, retention of knowledge and soft skills. Furthermore, integrating this educational tool in the teaching of a module (course) in the Mechanical Engineering programme at Aston University will be outlined, highlighting the effect of such intervention on students' experience and marks.

## LITERATURE REVIEW

As an education tool, it was claimed that one of the most important benefits of debate is that it promotes working together in teams and having a positive and constructive interaction when performing a collective task (Zare and Othman, 2013). Students who learn using cooperative approaches such as debate showed greater academic ambition and improvement, longer retention of the knowledge gained, higher level of critical thinking, higher self-esteem and more constructive communication. Furthermore, when compared with other individual study activities, this collaborative learning activity results in higher-level reasoning, more creative solutions and greater transfer of knowledge within the team itself and the wider classroom environment. Aiming to measure the students' perception about educational debates, it has been found (Goodwin, 2003) that while a few students reported distress and anxiety about the competitive nature of debates, the majority expressed positive feelings claiming that the debate encouraged them to explore the content of the course deeply and that it promoted independent learning for themselves.

In engineering courses, it was noted that non-mathematical courses such as material science can be mainly theoretical, leaving the educator with fewer options to encourage active learning. As a result, Hamouda and Tarlochan (2015) incorporated team debating as an education tool in the Materials Science module, in which students claimed that the applied method was very enjoyable, encouraging them to attend and to engage highly in the course, and enabled to let them reflect on higher levels of Bloom's Taxonomy. Moreover, it is stated that the students improved their time management and team working skills and student grades and attainment increased significantly. In a study conducted by Alford et al. (2002), it was claimed that using debate as a teaching tool in engineering course, such as Artificial Intelligence was highly supported by students. Authors recommended choosing a controversial topic within the subject to let students share and evaluate different viewpoints. To support their arguments, it was noticed that students needed to do independent research and to improve their verbal communication skills.

It has been mentioned by Snider and Schnurer (2002) that applying debate approach in education was found to push students to adopt a greater responsibility for comprehension of the subject and to invest more serious study effort. In learning controversial subjects, debating was found as a great tool to allow students to appreciate the complexity and the multi-faced nature of subjects. This education tool can provide students the opportunity to synthesize course information, encourage related research, improve critical thinking, and develop verbal communication skills. Debate sessions were introduced to 2<sup>nd</sup> year medical students by Mumtaz and Latif (2017), where over 180 students participated in opening argument, rebuttal,

formal debate, and in closing remarks from each side. It enjoyed an overwhelmingly positive reception with 78% of the students agreeing that it improved their critical thinking, 80% agreed that it helped them understand the importance of listening to different views, and 75% agreed that it helped them to realise different strategies to convince others. The public nature of the debate appears to motivate the students to perform well naturally (Aclan, Noor and Valdez, 2016). Moreover, the effect of this approach on soft and transferrable skills is greatly appreciated by students with communication and team-working skills seeming to receive the greatest benefit from this approach.

## **METHOD FOR THE ENGINEERING EDUCATION INTERVENTION**

The intervention took place in the academic year 2018/ 2019 as a part of the Engineering Design and the Environment module, which was delivered for the 136 students studying in the third year Mechanical and Design Engineering Programmes. The module aims to outline how engineering designs impact on the environment and to give an in-depth account of impacts in climate change and ocean acidification. Life cycle assessment is introduced as a method of categorising and quantifying impacts. In particular, students learn about the three main pathways of responding to the climate change issue, namely adaptation, mitigation and geoengineering. While adaptation focus is on building defences to limit damage occurred by climate change, mitigation aims to reduce the greenhouse gases, ideally to effective zero, and geoengineering has been seen as a radical response where mankind effectively take control on the climate using different artificial interventions. While these pathways are very different from the technical perspective, ethical considerations and social perception are at the core of the pathway choice. The module is assessed using an individual exam (70%) and a group presentation (30%) based on the group project in the three after mentioned pathways.

Following a brief scientific background on how climate change is happening, and the effect of greenhouse gases on the climate, the three pathways responding to the global issue are introduced. At that point, students are be given the opportunity to express their views on which approach is more effective, and indeed to choose their group project under that pathway. It was found that students were almost uniformly split into the three pathways. While group projects were made by 6 students in each group, the students were found to almost uniformly split into the three pathways. By implementing the debate as an education tool, the team aimed to increase the students' engagement, reflection and retention of knowledge associated with sustainability and responding to climate change.

While lectures give a detailed account of sustainability and support learning of different technologies under each pathway, the debate between students in different pathways serve as the backbone of the module. Students have a 10 mins window in each lecture to bring up new data/ perspective to enrich and stimulate the debate of the three pathways building on the students' independent research and their progress in the respected group projects. At the end of the module, a public session was made where each group presented on their project and how their approach to climate change is more efficient than others. A space for question and answers followed each presentation where other students tried to contradict the presented view. A following conclusion lecture was used to show the advantages of each approach, and how all different approaches are needed urgently, and side by side, to deal with this global and major matter.

The intervened students' attendance, satisfaction and attainment were compared with the 2017/ 2018 data where a similar delivery and assessment format were used. Therefore, it is

proposed that the studied intervention is the primary drive behind the change in the measured metrics.

## **RESULTS**

Instead of teaching different pathways used to respond to climate change using traditional lectures and tutorials, the new approach has used the educational debate as the backbone of the module which encouraged students' attendance and engagement throughout the module sessions. It has been noted that there was 32.5 % increase in student attendance at lectures and group projects sessions compared with the last version of the module, making this particular module one of the most attended ones in the final year. Feedback gained from students via an online survey at the end of the course also improved as compared with the data from the previous year, with special improvement of over 20% on the students 'encouragement and participation in the classroom. An improvement in the students' retention and level of the knowledge can be noticed with 8% higher average mark and 5% improved pass rate achieved. Other verbal and written feedback showed that a majority of students was found to be highly motivated to research beyond the lecture notes, to understand the multi-faceted nature of problems, and to appreciate the collaboration value inside the team, and in between other teams. The public debate session which was held by the end of the group projects was also seen by students as a great way to practice public communication with unspecialised audience.

## **DISCUSSION AND CONCLUSION**

From the results achieved, it is clear that implementing the debate as an education tool helped to improve the students' motivation, engagement, depth and retention of knowledge gained, and soft skills. Although using such approach is not typical for Engineering Education, the subject itself where students have the room for different views, along with briefing recent research projects under each pathway, helped the students to facilitate their choices and debating based on rich and accessible literature in the field.

There is generally a dearth in critical thinking development in engineering programmes, partly due to the increasingly crowded curriculum and the demands for developing technical competence and other professional skills. It is clear from the higher engagement and improved module feedback found in this study that there is a real need for developing critical thinking skills more deeply. The authors suggest a longitudinal approach to embedding critical thinking development throughout engineering programmes. With debate as one proven tool to help with this, future work is planned to use a similar approach in other modules taught in the same programme, namely, the major projects based learning modules and the final year project module.

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