Incorporating Active Learning Debate Sessions in Undergraduate Civil Engineering Transportation Courses

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Abstract

Moderated class debates have become one common form of active learning methods employed in various disciplines. This paper observes and traces the implementation of one active learning method – moderated student debate sessions – to undergraduate civil engineering students for their transportation courses at West Virginia University – Institute of Technology. In these sessions, students divided into groups were given the choice from several controversial topics in transportation to choose from and to debate being with or against this solution or project. The author describes these debate sessions and share the experience and results. In addition to the sessions' positive outcomes such as improving students' debating skills, results show that these sessions provided additional breadth to the understanding of the complexity of transportation and traffic issues, and also provided a level of excitement and challenge which positively influenced the students' attitude towards researching transportation engineering topics. As students prepared and studied these topics thoroughly, they indicated after the debate that it made them think differently towards transportation engineering issues. This paper also emphasizes the importance of using debate sessions towards fulfilling Outcome H (Updated 2017-2018 outcome 6) of the ABET accreditation outcomes.

Keywords: Debate Sessions, "Active Learning", Transportation Education, ABET Outcomes in Civil Engineering,

Introduction

There have been a long tradition of using moderated classroom debates, among other active learning methods, as a useful component of teaching methods for different non-engineering disciplines, such as Political Science [(1)]. Moderated educational debates help students develop skills to formulate clear, precise, and logical arguments [(2)]. Teams of students debate in class a question prepared in advance to help political science instructors advance their educational goals. Several studies [(1, 3, 4 & 5)] tested the merits such an approach has demonstrated on student understanding and communication of complicated political topics. These studies have addressed the optimal debate format and class levels/sizes, grading and evaluation methods. Oros [(1)] found that these structured classroom debates (SCDs), provided a powerful tool for helping students develop their critical-thinking skills, provide exposure to numerical political

views and help actively critique the work of others. Also, he found that these sessions help instructors encourage active class involvement beyond the few students who dominate classroom discussions. A report by the U.S Department of Higher Education [6] has stressed the need for a variety of teaching styles & active modes to be employed to keep student attention and recommended several active learning techniques, among which, debates was one recommended method to be used in University level courses.

Transportation and traffic engineering are essential disciplines that are taught to both graduate and undergraduate Civil Engineering students, as one of the main pillars of the Civil Engineering education. However, and because projects involving transportation directly affects our lives and has adverse impacts on the environment, the society, the economy and people's lifestyles, traffic and transportation problems touch people's lives in several levels and different ways. Therefore, transport planning and traffic engineering issues have widespread reactions from different people in the society and are always subject to debate from the public, affected stakeholders and government officials.

Debates have appeared to be among the most widely-used form of active learning used by political science instructors and the core of politics in making reasoned decisions [1]. Similarly, Transportation engineering courses also share some goals with political science courses. In addition to the traditional in-class lectures, some transportation instructors follow the models used in political science, which seek to teach students to think critically, to acquire basic research techniques, to develop skills of logical argumentation, and to improve oral and written communication skills [5]. Debates are believed also to lead to better retention and better ability to utilize these skills in future interactions that includes debating both political and engineering decisions.

This paper discusses the value of introducing and incorporating debate sessions into several different levels of types of civil engineering classes (with special emphasis of Transportation and Traffic Engineering courses). It also provides instruction of how to do this and the results of including it, especially when considering outcome "H" of the ABET accreditation outcomes [12] "*Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*", which was updated into outcome 5 in the 2017-2018 criteria "*Ability to recognize ethical and professional responsibilities in engineering situations and make informal judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*". In addition, this paper addresses how to accommodate the entire classroom and students of different academic performance and abilities through effective team assignment. It also describes grading options and methods of evaluation.

Results presented in this paper are based on the instructor's experience in conducting moderated class debates in five classes over five years (between 2012 to 2017) in two civil engineering courses – CE331 Transportation Engineering & CE432 Traffic Engineering – which involved more than 45 students of different levels (sophomore, juniors and seniors).

Class size ranged from 4 to 18 students. It is worth to note that these debate sessions were publicly advertised and attended, in which flyers were posted around the campus for all students and professors to attend the sessions, debate for the winning teams, and to answer an additional assessment questionnaire.

Lectures or Active Learning?

Several studies have compared traditional, lecture-based teaching methods to other pedagogical techniques such as "Active Learning and Problem-based Methods" [1, 2, 7, 8 & 9]. The former is the most favored, oldest known instructional technique. It includes assigned at-home reading supplemented by instructor lectures and written work (whether by essay or examination), submitted by the students. The latter involves any instructional methods that engage students in the learning process, which include collaborative learning, simulations, structured debates, or other forms of group and individual work), with a common goal of changing the dynamics of the classroom away from the traditional one-way flow of information from the instructor to the student. Lectures are inexpensive, familiar, efficient, and effective methods to deliver basic knowledge, but do not develop high-level application and evaluation skills.

Therefore, the literature [2, 8] show that student-centered active learning may be the most useful and academically positive approach for academic achievement, in which students apply and add to what they have learned in lectures, plus developing material mastering and critical thinking skills. Although active methods could be included as a comprehensive approach, critics of the traditional lecture-based techniques want to replace it with active learning approaches that provide students with opportunities to actively participate in the educational process [10]. However, the authors agree with other studies [2, 8] which call for integrating both methods into one coherent and compatible theme to make use of advantages of both methods and to avoid their shortcomings. The authors show that integrating debates into Transportation Engineering classes emphasize this idea, recognizing that lectures still better promote students' memorization, recall, and recognition of information. An amalgamation of both the traditional and active-learning methods may provide the most effective training for undergraduate students.

Debate Sessions Rules

Inspiring classrooms are where students are motivated and where instructors do more than mechanically cover the material and bring it to life [3]. Rather than asking students of their opinions, debates require student teams to make a specific choice and then prepare an argument in support of this selection, supported by broad research effort outside of the classroom. These sessions not only give students an in-class rich teamwork experience, but also improves skills such as critical thinking and civic engagement. It provides students with strength and confidence to take an explicit stance on a decision or argument. Moderated debates invoke real-life examples to corroborate their theoretical arguments. Motivated to persuade the audience to

their side, debaters can appeal to familiar practices to make their arguments relevant to other students' lives [2].

Each debate session consists of two teams – a pro team and a con team – and defend opposite stands of the same topic. These teams were also required to conduct a comprehensive research of the debate topic and prepare arguments to defend their position and in contradiction of those of their opponents. At the end of each debate session, other students, in addition to debate guests of students and professors, are asked to vote for the team that was able to better defend its position on this debate topic.

Debate sessions were introduced in five courses between 2012 and 2017, which included a vast array of students (more than 45 sophomore, junior, and senior students) in two different transportation level courses (levels 300 and 400). The instructor is keeping the same tradition and will be conducting the same session for the CE 331 Transportation Engineering course, being offered while this manuscript is finally written (Spring 2018).

Earlier in the semester, students were given a number of controversial topics and they provided their opinions on these topics and voted for their best topics. Based on these votes, debate topics were assigned and debate groups were created. Groups were required to work in groups outside of class to actively consider multiple lines of response to the question posed. Finally, students combine oral debate of the topic with a further development of their own views on the question in a follow-up individual written assignment. One of the instructional goals of using debates is to demonstrate to students how to differentiate different lines of argument, and how to anticipate strong counterarguments.

Debate sessions are one of the powerful educational techniques that motivates students to thoroughly occupy multiple sides (pro- and con- sides) of this carefully selected contestable transportation engineering argument or topic, in addition to considering all perspectives pertaining to this topic. Each class was divided into even competing teams, each team consists of three persons. The debate lasts a total of 20 or 30 minutes, depending on the total class size, 4 or 8 minutes rounds for the "pro" and "con" teams, in addition to 10 minute of rebuttal session and 4 minutes to vote for the winning team.

Writing skills are fundamental to the development of critical thinking skills [2] as it combines individual preparation skills, collective teamwork discussion and research skills. Therefore, the debate assignment is always complemented by a report assignment to be prepared by each debating team. This essay report includes the literature research results prepared to reach the team's argument and the possible arguments of the other team, in addition to counterarguments to these opposite arguments. Such report includes a definition of the topic being addressed, a logical presentation of the team's case, a logical refutation of the anticipated case of the opposing team, and any appropriate supporting documentation. This report is due immediately after the debate session. The main body should be no more than eight pages, with supporting documents as an Appendix. Debate grades were based on the

presentation, written report, and winning the debate votes. This debate constituted 10% of the final course mark. Some of the topics debated in these sessions include the following:

- Do you think WVU-Tech should have a deal with local bus transit agencies to provide a 60-mile new shuttle bus route between Beckley and Charleston for commuter students, employees and faculty?
- To increase the Safety on our roads, do you think the State of West Virginia should state more stringent and tougher laws for using handheld cell phones while driving?
- To increase the Safety on our roads, do you think the State of West Virginia should change the laws regarding older driver licensing (e.g., no license after the age of 70)?

The instructor should moderate the debate session effectively, first by choosing the right debate topics that are acceptable by students and can be argued strongly by both side. An additional level of active participation is to involve students in crafting and voting for some of the debate topics. Secondly, the instructor should communicate the debate rules to the students and debate guests. Good preparation for the moderated debate, specifying clear evaluation criteria, and gaining feedback on student performance from debate guests (other students and professors) and the instructor can greatly maximize the benefits of this technique and the attainment of the course goals. Table 1 [(1)] provides several debate presentation evaluation criteria which was used by the instructor and guests to assess the debating teams.

Table 1. Evaluation criteria for the oral debate component, *Source: Oros, 2007* [(1)].

- Has the team provided clear, coherent arguments?
- Has the team met the burden of proof, based on course materials and/or outside research?
  - In other words, is adequate supporting evidence provided?
- Were presentations clear and persuasive?
  - Are the speakers easy to understand?
  - Do the speakers make eye contact with the audience?
  - Is the team's delivery both dynamic and effective?
- Effectiveness of argumentation and reasoning
  - Were the arguments and counterarguments presented logically consistent?
  - Do the speakers find flaws or inconsistencies in their opponent's reasoning?
  - Is the team able to confront opposing arguments and rebuild their own case?

Overall, teams should be graded not only on the content of their presentations but also on the clarity and persuasiveness of their presentations.

ABET Accreditation Considerations for Civil Engineering Programs

Despite the significant improvements made in the civil engineering field to integrate the concept of sustainability [(11)], several engineering departments find difficulties with meeting outcome "*H*" required by ABET [(9,12)] "*the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and social context*", which was

updated into outcome 5 in the 2017-2018 criteria "*Ability to recognize ethical and professional responsibilities in engineering situations and make informal judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts"*[12]. Current curricula provide few opportunities to offer useful experiences that would address these outcomes, and therefore, these ABET outcomes have become a challenge to many engineering departments, a considerable task that entire teams of faculty are trying to address, limited by reduced department room and flexibility.

However, it should be noted that Engineering now is not only a profession driven solely by technical issues [9]. Engineers now need to consider sustainable issues, by understanding the global implications of their decisions on social communities, corporate economics, and the environment, which form the three pillars of sustainable design. Young people are more likely to be attracted to engineering, as a result of how engineering careers "make a difference" in the world, rather than emphasizing the challenge of math and science skills [9, 13]. Furthermore, the transportation field is constantly evolving, and is shifting away from the traditional design and construction process to a more holistic, context-sensitive planning process, which explores these three pillars of sustainability and incorporates innovative design techniques into the field (ITE 2015). Therefore, it is obvious that the ABET outcomes "*H/5*" are gaining more influence and importance for engineering education, as there is a need to educate the next generation of civil engineers with tools and concepts necessary to address global challenges.

For these reasons, debate sessions in transportation engineering courses are means to address the ABET outcomes "*H/5*" as they provide civil engineering students with understanding of the broad education and the effect of transportation decisions on the three pillars of sustainable engineering, which are embedded in the debated topics and the debate argument role playing.

In addition to developing individual debating skills, it is also believed that debate sessions help develop communication outcome *G* (or new outcome 4) [12], in addition to student group management and teamwork skills through participation in a teamwork activity. The main goal of every team is to win the argument of the debate and win the debate. This also could be essential for fulfilling the ABET objective *D* (or new outcome 7) "*Ability to function on multidisciplinary teams", "Ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment"*[12]. In addition, debate sessions add to providing students with skills to become life-long learners and knowing contemporary issues, by introducing a more innovative ways in teaching. This in turn, addresses the previous ABET outcomes, *I & J*. Table 2 highlights the different ABET objectives in which debate sessions add to the Civil Engineering curriculum, when compared to a transportation class project.

Table 2: Debate Session Addressing ABET Outcomes, Source ABET [12]

	ABET Student Outcomes	New ABET Outcomes (2017-2018) [12]	Term Project	Debate
a	Ability to apply knowledge of mathematics, science, and engineering	1. Ability to identify, formulate and solve complex engineering problems by applying principles of engineering science and mathematics	✓	
b	Ability to design and conduct experiments, as well to analyze and interpret data	3. Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions;	✓	
c	ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	2. Ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline	✓	
d	Ability to function on multidisciplinary teams	7. Ability to function effectively as a member of leader of a team that establishes goals, plans, tasks, meets deadlines, and creates a collaborative and inclusive environment.	✓	✓
e	Ability to identify, formulate, and solve engineering problems	Outcome 3	✓	
f	Understanding of professional and ethical responsibility	5. Ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in the global, economic, environmental, and societal contexts;		
g	Ability to communicate effectively	4. Ability to communicate effectively with a range of audiences;	✓	✓
h	Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	Outcome 5		✓
i	Recognition of the need for, and an ability to engage in life-long learning	6. Ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge		✓
j	Knowledge of contemporary issues	Outcome 6		✓
k	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Outcomes 1 and 2	✓	

Results

Results presented in this paper are based on experience with conducting moderated class debates in five classes over five years (between 2012 to 2017) in two civil engineering courses – CE331 Transportation Engineering & CE432 Traffic Engineering – which involved more than 45 students of different levels (sophomore, juniors and seniors). Class size ranged from 4 to 18 students. It is worth to note that these debate sessions were publicly advertised in campus by means of campus flyers posted, in which all students and professors are welcomed to attend, vote for the winning teams, and to answer an assessment questionnaire.

During this time span, and according to class debate evaluations, students consistently credit the use of these moderated debate sessions as a fun and effective method for instruction. They praised these sessions as it encouraged participation and winning, plus generating invaluable discussion over essential range of transportation and traffic engineering topics, which included policy, safety, congestion and transport funding. Moreover, statistical analysis of the course and debate evaluations indicated that the use of such debates caused increase in student enjoyment, and interest in course topics and readings, when compared to course where such debates were not used (e.g. having a project assignment in the course instead).

Student responses to classroom debates have been overwhelmingly positive, as conveyed both through oral comments inside and outside of class and on written student evaluations of the course conducted at the end of each semester. One of the feedback comments from students read the following: “I have really enjoyed participating in this debate session. The motivation to win this debate encouraged me to read more about the topic of elderly drivers”

Indirect measures included an assessment survey was used at these sessions, which supplement the traditional direct assessment and course evaluation feedback. Assessment surveys were completed by the debating students. These surveys asked students their level of satisfaction, familiarity and understanding of the topics. Similar surveys were completed by the debate visitors (professors and students) asking them their level of satisfaction on the debate topics, student performance and overall debate process. These survey asked students if the debate was useful in understanding contemporary issues in Traffic and Transportation. Responses included the following a) Strongly disagree [weight = 0], b) disagree [weight = 1], c) neutral [weight = 2], d) agree [weight = 3] and e] Strongly disagree [weight = 4]. Figure 3 shows the distribution of number of students and visitors based on each response for the total of five debate sessions. The weighted score of this survey was 126 out of 184points, which is considered a high weighted score, which indicated a total satisfaction of this activity.

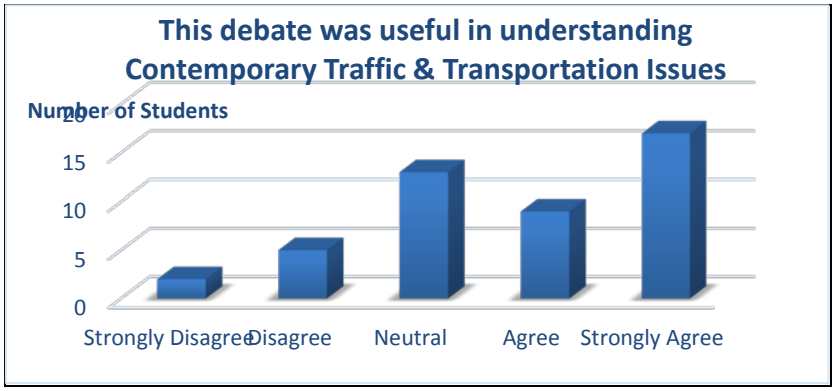

Figure 1: Questionnaire Survey Distribution Results

In addition, direct course assessment surveys for ABET purposes were completed by all students to test their learning outcomes, according to Table 2. The results indicate that student self-reporting showed a high satisfaction rate, between 75% and 80%.

In addition, the average final for all debating students, show high student performance of all students. Even teams who have lost their debate sessions by visitor voting, achieved high marks in their reporting assignment and presentations, with an average of 8 marks out of 10.

Conclusions & Recommendations

This paper measured the development and introduction of moderated student debate sessions – to undergraduate civil engineering students for their transportation courses at West Virginia University – Institute of Technology. Students divided into groups were given the choice from several controversial topics in transportation to choose from and to debate being with or against this solution or project. In addition to the sessions' positive outcomes such as improving students' debating skills, results show that these sessions provided additional breadth to the understanding of the complexity of transportation and traffic issues, and also provided a level of excitement and challenge which positively influenced the students' attitude towards researching traffic engineering topics. Results also showed a high weighted mark of satisfaction among both students and class guests (126/184). The student assessment reports also show that the direct achievement of the H/5 ABET outcome is between 75% and 100%. As students prepared and studied these topics thoroughly, they indicated after the debate session that it made them think differently towards transportation engineering issues. We still recommend additional and improved assessment surveys and questionnaires to further assess the effects of using these debate sessions in Transportation and Traffic engineering courses, and probably including before and after surveys.

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