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Engineering Grand Challenges Video Competition - A Project Learning Tool in a Cross-disciplinary Class

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Abstract

In 2007, the National Academy of Engineering (NAE) began working with a marketing company to rebrand engineering and better communicate the importance of engineering to the public and potential future engineers. The resulting messages were 1) Engineers are creative problem solvers, 2) Engineers make a world of difference, 3) Engineering is essential to our health, happiness, and safety, and 4) Engineers help shape the future. In 2008, the NAE launched the Engineering Grand Challenges website.

The fourteen grand challenges highlight key challenges facing modern society that reinforce the engineering messages of how engineers and their creative problem solving skills are essential to improving our world and shaping the future.

The NAE kicked off its Engineering for You Too (E4U2) national video competition in order to highlight how engineering will create a more sustainable, healthy, secure and/or joyous world by addressing the NAE Grand Challenges for Engineering. The E4U2 project was a six week project assigned to the students in the cross-disciplinary class at Auburn University. The goals of the project were 1) To create awareness about the NAE grand challenges among the future engineering and business students and 2) To explore the feasible solutions for the chosen grand challenges and put it in simple way that a general audience can also understand the technology behind these potential solutions. The students were divided in six teams (4-5 students in each team) to make six two-minute educational videos. Each team was divided based on the DiSC personality assessment test and had a good mix of engineering and business students. The project involved aspects like researching potential solutions for the grand challenges, storytelling, script writing, and video production, editing and marketing. The project was reviewed and evaluated every two weeks and feedback was given on the videos by professional video creators and educators. The following topics were chosen by the teams to develop videos

1. Make Solar Energy Economical
2. Advanced Personalized Learning
3. Provide Energy from Fusion
4. Provide Access to Clean Water (chosen by two groups)
5. Restore and Improve Urban Infrastructure

Three teams made it to the final stage of the competition. Qualitative feedback was taken and the students liked this project as it was different from the regular class project and received very positive and encouraging reviews. This paper will review the process of implementation and evaluation of this video project in a cross-disciplinary setting. The results of the content analysis will also be discussed in the paper.

Introduction

The Engineering Grand Challenges has been used in several studies to 1) improve perceptions about engineering and math and science education in high school students[1]; 2) create engagement and motivation in freshmen engineering courses[2]; and 3) promote engineering persistence among women through alignment of occupational values and perceptions of the field. Many educational modules have been created using the engineering grand challenges in teaching different engineering concepts. The two NAE grand challenges summits held in London (2013) and Beijing (2015) demonstrated that a community of engineers who take cross-disciplinary, challenge-based approaches to their practice may change the world.[3] Thomas et al.[4] defines project-based learning as "a model that organizes learning around projects". Mills and Treagust[5] claim that a mixed mode approach, involving traditional lecture with project based components, appears to be the best way to satisfy industry needs, without sacrificing knowledge of engineering fundamentals. Project based learning has been effectively used for the past 30 years to teach several courses and concepts at different levels of education.[6, 7, 8] So, the need for cross-disciplinary challenge-based approaches can be combined with an effective project-based pedagogy to teach courses. The main educational objectives of this course were:

1) Engineering students learn about importance of ethics, decision making, team working, design, marketing and communications in solving a real-world problem,
2) Business students learn about importance of engineering technologies and engineering design and their role in innovation and ethics in solving a real-world problem,
3) Both group of students use presentations, project management, team work, and write-ups to enhance their learning experiences.

The course also involves elements like real-world case studies, lab exercises, guest lectures and final comprehensive project involving both business and engineering technologies and concepts. The NAE came up with fourteen grand challenges[9], the world is currently facing and started the E4U2 video competition in spring 2015. The instructors of this course thought this would be an ideal project learning tool where both engineering and business concepts can be brought together in a fun and unique manner. The idea was to make the engineering students work on the possible technical research solutions to address a grand challenge while the business students work on advertising, marketing and search engine optimization concepts for the video. Such a cross-disciplinary project motivates and engages both business and engineering students while connecting the course objectives to the project. It also initiates exchange of ideas between engineering and business students. In the next sections, we will discuss the E4U2 project details, its classroom implementation, evaluation and feedback from the students.

Project details

The E4U2 video competition[10] opened on January 5, 2015 and the deadline to turn in the two-minute video was March 2, 2015. The competition was open to individuals in four different categories: 1) Grades K-8, 2) Grades 9-12, 3)2- year college through graduate school and 4) General Public. The student teams who developed the videos were under the third category. The "Best Video Overall" was be awarded $25,000. There was a People's Choice Award of $5,000 and the top videos in each competition category were eligible for a prize of up to $5,000. Submissions were judged by a panel appointed by the President of the National Academy of Engineering (NAE) that includes professionals from various engineering fields and the film and

media industries. Members of the judging panel considered the following criteria in making their selections:

a) Creativity in the content selection and presentation;
b) Anticipated breadth of public appeal and interest; and
c) Effectiveness in highlighting how achieving one or more of the NAE Grand Challenges for Engineering will lead to a more sustainable, healthy, secure, and/or joyous world.[7]

Classroom implementation

The E4U2 video project was implemented in a BET class at Auburn University in spring 2015. The class had a total of 29 students of which 18 were pursuing engineering and 11 were business majors. In the beginning of the semester, the class was divided into six teams based on their DiSC personality[11] profiles and majors. The instructors made sure that each team had an equal mix of engineering and business students and did not have more than two dominant personalities in a team as that might create conflicts and clashes within the team. The student teams were asked to choose one of the fourteen grand challenges and were given the task to create a two- minute video focused on their grand challenge. This was a six week project. The following were the deliverables (deadline) for this project:

i. E4U2 Write-up – Story telling and scripts for the video (second week);
ii. Presentation # 1 – Rough draft of their video presentation (fourth week);
iii. Presentation # 2 – Final video with all the edits (fifth week).

Table 1 shows the links to all the videos created by the student teams.

Team	***Topic***	***Video Link***
Team 1 - Finalist 1	Nuclear Fusion	https://youtu.be/C1pg4kiqGjk
Team 2 - Finalist 2	Make Solar Energy Economical	https://youtu.be/ulI2d48EUNg
Team 3 - Finalist 3	Advanced Personalized Learning	https://youtu.be/WpWkFs5ha_U
Team 4	Infrastructure	https://youtu.be/g3gjDueOPNI
Team 5	Clean Water Access 1	https://youtu.be/aEjQwbcZzEs
Team 6	Clean Water Access 2	https://youtu.be/XMKYlemqp9o

Table 1. Team topics and video links

Evaluation of the project

For any project to be successful, a rigorous and effective evaluation is necessary. The E4U2 project was evaluated at different stages of the project. The first evaluation was done at the two week mark. The student teams came up with their script and storyboard. The Producer and Director of Media Production Group at Auburn University helped the student teams with their storyboards and scripts for the video. The students really liked the constructive criticism provided by the experts. After implementing the tips and feedback from the Media Production Group, the second evaluation was done at the four week mark. The students came up with their initial version of the video. The student teams were evaluated in three categories which are

mentioned in the project details section. These categories were chosen based on the evaluation criteria of the judges of the contest. The Website Content Editor at the Office of Communication and Marketing at Auburn University did an excellent job in critiquing the initial version of the videos and providing great feedback. The students took those comments and created the final version of their videos. The third evaluation was done at the five week mark. We had a panel of judges to evaluate the videos based on a rubric shown in Appendix A. Peer response was taken at each stage of evaluation which was very effective in developing the videos. The students took all the feedback from the experts and turned in their final version of the video on March 2, 2015. Three teams who were chosen to be finalists had to sign a consent form and send it to NAE. The consent form in Appendix B is a proof showing three teams were chosen as finalists.

Feedback from the students

The students were tested on the content of engineering grand challenges in one of their class exams. They were asked to pick three out of the five grand challenges mentioned in the abstract. They could not pick the topic they were going to present. The questions were as follows:

1. List three reasons why each of the grand challenges (they picked three out of the five) are important;
2. List two possible engineering research solutions which aim to solve each of the grand challenges you have chosen.

There were some very interesting responses. Some of the following responses for the first question shows the knowledge content and awareness of the students about the grand challenges.

"Help the environment because fossil fuels emissions are clouding and damaging the atmosphere"

"Solar Energy is a safe, clean and environmentally friendly source of energy, but it is expensive"

"1 in 7 people die from some type of water related disease"

"Fossil fuels are expensive, harm the environment and are being used at a higher rate than they are being produced"

"A child dies every 20 seconds because of lack of access to clean water"

"Bridges and roads only last 50 years and we are currently not fixing them"

"Everyone learns differently and uses a different part of the brain while learning"

The responses for the second question reveals the engineering thinking and marketing/advertising skills of both business and engineering students. Some of the responses were:

"Web-based classes that are individualized and games that teach subjects rather than lectures"
"A joint nationality research operation is working now to develop an early model. Based in Europe, it is interesting that so many great minds cooperate"

"Build more fusion labs to make fusion energy more prevalent"

"Using the concept of photosynthesis in plants to store energy"

"Desalination techniques for people who live near an ocean"

"Research new technologies to increase efficiency of solar panels"

"Computer software that can pick up on students' learning style and help teach/explain topics in a way that they understand"

"Solar mirror farms represent a significant step forward in solar collection technology. Concentrated solar heat can be easier to use than conventional ray collection technique"

"Increased awareness and funding truly could solve the problem"

The above responses for both the questions from the students clearly indicates that this project created awareness about all the engineering grand challenges selected by the students. It also shows that the students understand the importance of solving these grand challenges. Some open ended questions were asked to get feedback about the E4U2 video project.

When the students were asked how did they like working on the National Academy of Engineering (NAE) video development project, majority of the students said they really enjoyed working on this project and described it as fun, challenging, useful and unique. Some of the student comments when they were asked what you learned from this project were:

"I learned a lot about the challenge we chose, nuclear fusion, and also about the challenges chosen by the other groups"

"This was a challenging project where we learned how to use different technologies and learn about entirely new concepts"

"It allowed us to join a national competition and learn how to advertise problems/solutions we had for this world"

"I was able to learn more about the great issues our generation is currently facing and also about effective presentation in a video"

"I genuinely enjoyed working on the NAE video. It provided incredible insight into making a product that will correlate with direct relevance to my past work in the BET department"

"I enjoyed the video project, for it gave me a glimpse into advertising/marketing process. Additionally, it forced me as an engineer to communicate scientific principles to a general, less specialized audience"

"Getting to learn all about the various problems that engineering could help to solve was fascinating"

The students were also asked which element of the course 1. Case Studies 2. Lab exercises 3. Guest Lectures 4. Video Project, did they like and why? Figure 1 shows the student responses to the question.

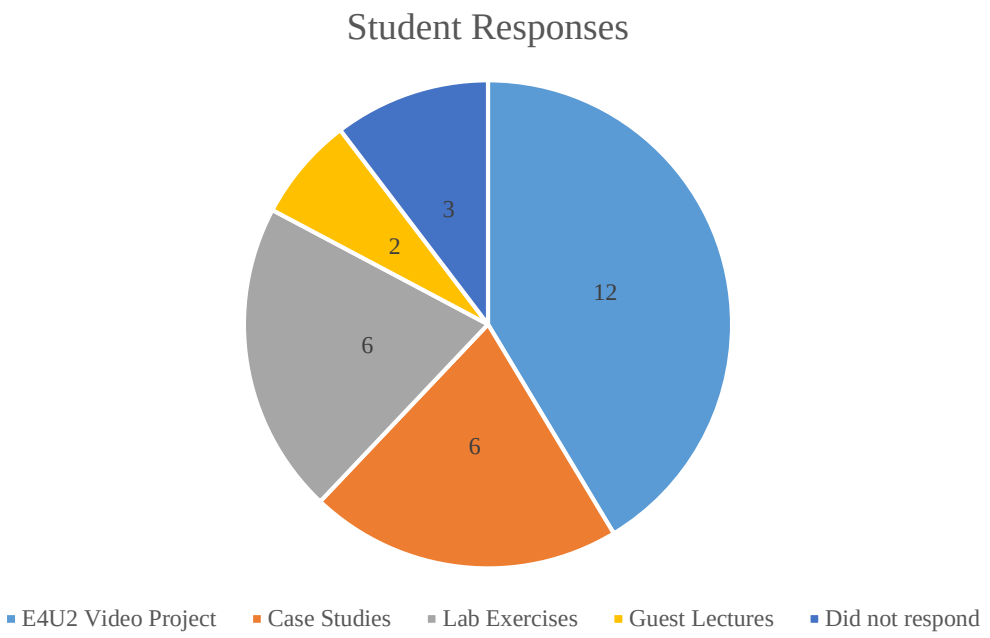

Figure 1. Student Response to the course elements they liked

Twelve students said they liked the video project, six preferred case studies, another six students liked the lab exercises, two students preferred guest lectures and 3 did not respond to this question.

Conclusion

The E4U2 video project was successfully implemented in a cross-disciplinary course. The project helped students appreciate the educational objectives of the course. The student responses to the open ended questions showed that the majority of the students found the project to be fun and enjoyable. They commented that the E4U2 project made them learn new engineering technologies and created awareness about the engineering grand challenges faced by the modern society. Some students also said that they learned marketing and advertising skills through this project. The peer evaluation results and comments showed that the students had a better teaming experience working on this project.

Future research

Smith and Weiss's[12] findings suggest that teachers' professional development leads to an increase in their pedagogical content knowledge; this in turn results in changes in classroom practice, which ultimately produces improvements in student achievement. They also show that curriculum materials play an important role in improving student achievement. There is a strong need to develop innovative curriculum materials that can motivate k-12 students to pursue STEM careers. The videos developed by the student teams during this project will be a part of a bigger project and will be used to develop hybrid educational modules linked to engineering grand challenges to improve science and math concepts in k-12 curriculum.

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Appendix A

E4U2 Final Video Presentation Rubric

	Poor				Average					Superior
CONTENT	1	2	3	4	5	6	7	8	9	10
Creativity in the content selection and presentation										
Anticipated breadth of public appeal and interest;										
Effectiveness in highlighting how engineering will create a more sustainable, healthy, secure, and/or joyous world by addressing the Grand Challenge for Engineering.										
Speaking volume, speed, and clarity are appropriate										
Images or props used in explanation										
Logical and intuitive sequence of information presentation										
Graphics and/or text enhance video										
Overall Evaluation										

Comments:

Appendix B

Consent Form for NAE E4U2 Video Competition Finalists

Congratulations! You have been selected as a finalist in the *Engineering For You Video Contest 2 (E4U2): NAE Grand Challenges for Engineering*. We will begin the process of final judging of Submissions shortly. Please review the contents of this letter, print out the letter and check the boxes as appropriate, sign it, and return a PDF of the signed, completed letter to nflores@nae.edu by **5 P.M. EDT on April 30, 2015**. Please note that for children under the age of 18, a parent or legal guardian must complete and sign this form. Note also that if you entered the contest as a member of a contestant team, every member of your team must complete and submit a separate copy of this form.

Provisional Assignment of Copyright/Agreement to Provide Written Permissions

As provided in the rules, winners must assign their copyrights to their Submission to the National Academy of Sciences/National Academy of Engineering. Accordingly, if ☑ *I am* / ☐ *my child is* selected as a winner, I hereby:

☑ Irrevocably grant and assign exclusively to the NAS/NAE all rights, including copyright interests in the videos, under all laws, treaties and conventions throughout the world, in all forms, languages and media, now or hereafter known or developed without limitation. I understand that use, publication or dissemination of the winning video may be permitted at the discretion of NAE, as approved in writing in advance by the NAE.

☑ Agree to provide NAE with copies of all necessary written permissions obtained by the entrant.

Finalist Certifications:

☑ I hereby certify that I have complied with the "Complete Rules and Regulations" of the contest and I continue to agree to all of the terms and conditions as set forth in those rules. (A copy of the "Complete Rules and Regulations" can be found at: www.nae.edu/e4u2)

FOR FINALISTS UNDER THE AGE OF 18:

☐ I hereby certify that I grant permission for my child to participate in this contest.

☐ I hereby certify that my child has complied with the "Complete Rules and Regulations" of the contest and I continue to agree to all of the terms and conditions as set forth in those rules. (A copy of the "Complete Rules and Regulations" can be found at: www.nae.edu/e4u2)

PLEASE COMPLETE, SIGN AND RETURN THIS LETTER IN PDF FORM TO nflores@nae.edu NO LATER THAN 5 P.M Eastern Daylight Time (EDT), APRIL 30, 2015. FAILURE TO COMPLETE AND RETURN THIS LETTER WILL RESULT IN YOUR SUBMISSION NOT BEING FURTHER CONSIDERED

Printed Name of Entrant: _____

Printed Name of Parent/Legal Guardian (if entrant is under 18):_____

Signature of Entrant (if entrant is 18 or over):_____

Signature of Parent/Legal Guardian (if entrant is under 18):_____

Date: 04/23/15