Using College Student Competitions to Recruit Middle-School Students to Engineering: The Visual Display Competition at the ASCE 2011 Southeast Student Conference

Steven M. Click [1]

Abstract – This paper provides information about a recent Visual Display competition at the ASCE 2011 Southeast Student Conference. Teams of civil engineering students were challenged to create a visual display which would teach an engineering design or problem-solving process to middle school students in a career-fair atmosphere. Of the twenty-six schools attending the conference, sixteen entered the visual display competition. During the conference, middle schools from the surrounding area were invited to come and view the displays. Included in the paper is information regarding the competition rules, judging and scoring, and anecdotal comments from both college and middle school participants.

Keywords: outreach, middle school, engineering outreach, competition, scoring rubric, K-12

INTRODUCTION

The process of recruiting students to engineering fields in general – or to any university in particular – now requires advanced contact with students. Gone are the days of college fairs for graduating high school seniors. The best students are making their choices much earlier than their senior year. Perhaps more importantly, if students have not discovered and interest in engineering fields before entering high school, they are unlikely to take the advanced math courses needed to help them succeed in a college engineering program. In a continuing effort to recruit students to engineering fields, many entities including ASEE have started programs which provide or encourage outreach to middle school students, hoping to spark an interest which will lead to a future in engineering… and to proper selection of high school courses.

As the parent of a 4th grader, the author has a personal understanding of the challenges involved in such outreach efforts. Such challenges include finding grade-appropriate material, finding speakers who interact well with middle-school students, and finding topics which spark the interest of the audience. Complicating the process is the fact that a topic of interest to one student may not be of interest to another. This creates a desire to provide multiple opportunities with different topics in hopes of reaching a broad range of students.

In Spring 2011, the ASCE Southeastern Student Conference was hosted at Tennessee Tech Universtiy. Twenty-four universities from across the southeast plus two international universities participated in the conference. One of the annual competitions is a Visual Display. In an attempt to blend the desire for outreach to middle school students with the opportunity provided by the student competition, the author proposed that the visual display competition be used for more than just peer competition, but also as a starting point for outreach.

[1] Steven M. Click, Associate Professor, Department of Civil and Environmental Engineering, Tennessee Technological University. Campus Box 5015, Cookeville, TN 38505.

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THE RULES

The first step in creating a quality outreach competition is to provide reasonable guidance to student participants without restricting their creativity. As such, development of the rules was a fairly straightforward process. For the most part, the rules were more about making sure that the resulting display could be used in the final venue without the need for excessive support. What follows is a discussion of three of the more significant rules. The complete rules are located online at:

http://www.tntech.edu/images/stories/engineering/asce/2011.sesc.visual.display.rules.final.pdf

Rule 2: Objective

2.1 The objective of the visual display competition is for each chapter to prepare and present a civil engineering topic to middle school students during conference and before, if possible.

This rule introduces the competitors to the basic purpose of their display – engineering outreach to middle school students. It also hints at one of the innovative aspects of the scoring rubric (discussed in detail in the next section), namely that the outreach would not be limited to the competition period at Tennessee Tech, but should in fact begin before they come to the conference.

Rule 4: Logistics

4.1 One 3' by 8' table will be supplied for each team. All other materials must be supplied by the team members themselves.

4.2 All electronic materials must be powered by a battery throughout the entire competition. No power outlets will be provided for any team.

4.3 If teams plan to give out materials to the middle school students during competition, they must bring enough materials to last throughout the entire competition.

4.4 Each team may be judged at any point during the 3 hour display period. If your team runs out of materials or if your electronics are not functional at the time of judging, you will receive a lower score as a matter of course.

Together, these rules ensure two key things – that the displays will fit in the venue and that the experience for middle school students will remain consistent through the entire competition period. As noted in item 4.4, the competition lasted for 3 hours. During this time, over 200 middle school students were in attendance to experience the presentations. Local middle schools were invited to come, and were scheduled as either early or late participants to help improve their opportunities for one-on-one contact.

Rule 7: Judging

7.1 Judging will be performed by multiple independent panels composed of a university professor, a college student, and a professional educator.

To help ensure high-quality presentations, and extremely detailed scoring rubric was developed (discussed in detail in the next section). With this rubric available, the opportunity was available for diverse judges – in this case, a

team which included an engineering faculty, a college student (peer), and a professional educator were used as judges. Knowing in advance that their work would be evaluated by such a wide variety of perspectives forced teams to consider all these views when creating their display, and (hopefully) resulted in better quality presentations.

THE SCORING RUBRIC

As noted above, one of the keys to the success of this competition-outreach was the creation of an extremely detailed scoring rubric. Student competitors were provided the rubric in advance, and could create their displays with high marks in mind. The rubric was broken into four primary sections, presentation quality, engineering content, educational goals, and bonus points. Each section had two or more scoring categories, each of which were worth up to five points. Each of the three judges on a team would then score each presentation in each category using either full or half points.

Because the scoring rubric served as a guide to student competitors, its contents – and associated goals – will be discussed in detail below, beginning with scoring for presentation quality. Note that the full rubric is available with the full rules at the website noted above.

Category		Points					
		0	1	2	3	4	5
Presentation Quality	**Quality of Display Materials**	No display materials	Insufficient display materials which are of poor quality and/or poorly organized.	Neat and well organized but insufficient display materials -or- Sufficient materials but poor quality and/or poor organization	Display materials are sufficient, of acceptable quality, and reasonably well organized.	Display materials are of high quality and are well organized. Pass-by students could possibly learn if the display is unattended.	Display materials are of excellent quality and very well organized. Pass-by students could easily learn even when the display is unattended.
	Use of Display Materials During Presentation	Ignored display during presentation	Minimal and/or very poor use of display materials during presentation -or- Much too often (75%), presenters read directly from the display board rather than using it as an aid.	Below average use of display materials during presentation -or- Too often (50%), presenters read directly from the display board rather than using it as an aid.	Average use of display materials during presentation. Materials provided some support to attending student learning.	Good use of display materials during presentation. Materials improved and/or reinforced learning for attending students.	Excellent use of display materials during presentation. Materials greatly improved and/or reinforced learning for attending students and prompted self-learning opportunities.
	Quality of Presentation	Presenters were either not well spoken or were not in appropriate attire -and- Presenters did not know their material well enough to provide an adequate presentation.	Presenters were either not well spoken or were not in appropriate attire -or- Presenters did not know their material well enough to provide an adequate presentation.	Presenters were well spoken, in appropriate attire, and provided an adequate presentation.	Presenters were well spoken, in appropriate attire, and knew their material well enough to provide quality team presentations.	Presenters were well spoken, in appropriate attire, and knew their material well enough both to provide quality team presentations and to divide and provide multiple concurrent presentations to students arriving at different times	Presenters were well spoken, in appropriate attire, and knew their material well enough both to provide high quality team presentations and to divide and provide multiple concurrent high quality presentations to students arriving at different times

While the inclusion of points for presentation quality seems obvious, the key to the rubric is the way it defines what a "quality" presentation really is. Unlike the engineering content discussed below, it should be possible for student competitors to achieve high scores in all three categories. The goals for these high marks, however, are ambitious. For the best score in quality of display materials, student competitors must create a display which could serve as an unattended learning tool. For the best score in use of display materials, student competitors had to create displays which were a functional part of their presentation. Finally, for the best score related to their ability to present the material, all participants needed to know the material well enough that they could individually interact with middle school students simultaneously without a drop in learning quality.

Next, consider the scoring for engineering content.

Category		Points					
		0	1	2	3	4	5
Engineering Content	**Inclusion of Conference Theme**	Conference theme not mentioned or implicitly included.	Conference theme is mentioned or referred to, but not a significant portion of the presentation. Students do not gain new understanding of topics related to the theme.	Conference theme is included in the presentation. Attending students become aware of the theme and gain some understanding of related topics.	Conference theme is a significant part of the presentation - attending students learn about a topic related to the conference theme.	The conference theme provides the focus of the presentation - attending students learn about a topic specifically related to the conference theme.	Conference theme fully integrated as the focus of the presentation - attending students learn about a topic specifically and directly related to the conference theme and gained understanding of the importance of the conference theme to their everyday life.
	Create Interest in CEE Professions	Topic not linked to CEE professions.	One or more CEE professions are mentioned, but these are unrelated to the presentation topic	Presentation topic is directly tied to one or more CEE profession, but these professions not mentioned during presentation	Material directly tied to one or more CEE professions which are mentioned in the presentation.	Presentation directly identifies and describes one CEE profession with direct ties to presentation materials. -or- Presentation topic is directly tied to multiple CEE professions which are mentioned in the presentation.	Presentation topic is directly tied to multiple CEE professions which are identified and well described during the presentation.
	Engineering Design & Analysis	No engineering design or analysis process.	The presentation topic uses either the engineering design or analysis process, but that use is not readily apparent.	The presentation topic uses either the engineering design or analysis process, and that use is readily apparent.	The presentation both uses and describes either the engineering design or analysis process.	The presentation either... Teaches an understanding of the engineering analysis or design process, -or- Describes and teaches how to apply either the engineering analysis or design process to a particular problem.	The presentation topic teaches both... a fundamental understanding of either the engineering analysis or design process -and- how to apply that process to a particular problem.

The engineering content scoring was specifically created to force student competitors to choose where they would try to earn points. It would be extremely difficult, if not impossible, to earn perfect scores in all three of these categories, especially given the 15-minute time period recommended for a full presentation. This resulted in a wide variety of presentation types – some focused on the conference theme, some on professions, and some on the design or analysis process. This variety helped to reach more middle school students, most of whom were able to find one or more presentations which appealed to them.

The conference theme was "Green your Routine," a reflection of the current trend toward more environmentally conscious engineering practices. This area seemed especially appealing to middle school students, as they were able to see more of how this attitude is important to their everyday life, rather than just a repetition of the "reuse, reduce, recycle" mantra. One display even showed how an on-campus building could be retrofitted to significantly reduce its environmental impact.

Overall, anecdotal evidence suggests that most groups recognized that they could not achieve a perfect score in all categories, and as a result they attempted to get high marks in two categories while not worrying about the third.

Next, consider the scoring for the educational goals of the displays.

Category		Points					
		0	1	2	3	4	5
Educational Goals	**Appropriate Grade Level for Material**	Presentation content is not suited to middle school student capabilities - it is either too advanced or too simple.	Some (25%) of the presentation content is appropriate for middle school students, with a reasonable compromise between 6th and 8th grade skills and competencies. The rest is either too advanced or too simple.	About half of the presentation content is appropriate for middle school students, with a reasonable compromise between 6th and 8th grade skills and competencies.	A majority (75%) of the presentation content is appropriate for middle school students, with a reasonable compromise between 6th and 8th grade skills and competencies.	All of the presentation content is well suited to middle-school students, with a reasonable compromise between 6th and 8th grade skills and competencies.	All of the presentation content is perfectly suited to middle-school students, with presenters introducing appropriate minor changes for differences between 6th and 8th grade (or individual student) skills and competencies.
	Level of Student Interaction During Presentation (Active Learning)	No student interaction during the presentation.	Students are given opportunity to ask questions, but are rarely actively engaged during the presentation.	Students are engaged via interactive components such as verbal interaction or hands-on activities during a small portion of the presentation.	Students are engaged via active learning techniques during at least half of the presentation using either verbal interaction or hands-on activities	Students are engaged via active learning techniques, either... By using verbal interaction or hands-on activities for the entire presentation -or- By using both of those methods over the majority (75%) of the presentation.	Students are fully engaged via active learning techniques throughout the presentation, including both verbal interaction and hands-on activities.

These two categories were the primary reason that the judging teams included a professional educator. In fact, only that judge's score was used for this category (and the professional educators were not asked to judge engineering content). The purpose in including these scoring categories was to encourage student competitors to look into the capabilities of middle school students and into what active learning really is. Based on the scores that were awarded in these categories, it appears that most of the student competitors were successful in both these categories. The result: a better experience for the middle school attendees.

Finally, consider the bonus point category.

Category		Points					
		0	1	2	3	4	5
Bonus Points	**Pre-Conference Presentations**	No evidence submitted for pre-conference presentations.	Poor or incomplete evidence submitted for one applicable event.	Poor or incomplete evidence submitted for two applicable events.	Appropriate evidence submitted for one applicable event. -or- Poor or incomplete evidence submitted for three applicable events.	Appropriate evidence submitted for two applicable events.	Appropriate evidence submitted for at least three applicable events.

The primary goal of this entire competition was to encourage outreach to middle school students. As such, a single 3-hour event for schools located near Tennessee Tech seemed pale in comparison to the possibilities. Therefore, student competitors were given bonus points for making presentations at middle schools near their university campus before coming to conference.

Of the twenty-six universities who came to the conference, sixteen participated in the visual display competition. Of these sixteen, six schools reached out to their local middle schools and gave presentations. While this was not the level of participation desired, it did mean that at least thirteen middle schools across the southeast (and China!) had groups of civil engineering students visit to give presentations.

SCORING RESULTS

In the final analysis, the value of any rubric is its ability to provide consistent, reasonable evaluation. In this particular case, the goal was to create a rubric that would provide differentiation between entries and identification of 1st, 2nd and 3rd place. The resulting scores from the conference are shown below without school names.

Quality of Display	3.125	2.750	3.250	3.250	3.000	4.375	2.625	4.250	3.875	3.875	3.625	4.625	2.625	3.625	2.625	2.750
Use of Display	4.500	3.375	3.875	2.625	3.250	3.750	3.875	4.375	3.250	3.125	2.125	4.500	3.250	3.500	3.875	2.625
Quality of Presentation	3.500	3.375	3.375	3.000	3.000	3.625	3.250	3.875	3.625	3.625	3.375	4.625	3.000	4.375	3.500	3.750
Conference Theme	2.833	2.500	1.833	2.000	1.667	4.167	3.833	3.833	4.167	1.833	4.167	4.167	1.500	4.667	1.833	3.167
CEE Professions	3.167	3.667	3.333	2.667	3.500	4.167	3.000	3.500	3.167	3.500	2.333	4.000	3.167	3.000	2.500	2.000
Engineering	2.500	2.500	4.500	4.167	3.000	2.833	2.833	3.833	2.500	3.667	1.833	3.500	3.333	4.000	2.667	2.000
Grade Level	3.000	3.000	3.250	3.000	3.250	3.250	3.500	4.500	3.250	3.500	4.000	5.000	3.750	3.500	4.250	3.000
Student Interaction	1.500	2.500	4.500	1.000	3.000	2.750	4.500	4.250	3.250	4.500	2.500	5.000	2.750	3.500	4.500	2.500
Bonus - PreConference	0.000	0.000	0.000	0.000	0.000	4.000	3.000	5.000	0.000	0.000	3.000	4.000	0.000	0.000	3.000	0.000
Total	**24.125**	**23.667**	**27.917**	**21.708**	**23.667**	**32.917**	**30.417**	**37.417**	**27.083**	**27.625**	**26.958**	**39.417**	**23.375**	**30.167**	**28.750**	**21.792**
First Place Score =39.417												1st				
Second Place Score =37.417								2nd								
Third Place Score =32.917						3rd										

While this particular table skips the step of averaging together scores from multiple judges, it does get to the heart of the matter. The resulting totals did provide for a consistent and reasonable evaluation of each group's participation in the event and also provided a clear indicator of the top three teams.

ANECDOTAL COMMENTS

Both during and after the competition, the author asked judges, student competitors, and middle school participants about their experiences. Some consensuses are:

- Middle school students greatly enjoyed the event. All of them could name a "favorite" display quite quickly, and none of their comments suggested that they thought everything was boring. This indicates success.
- Middle school students seemed more aware of and more interested in engineering as a career.
- Middle school teachers reported that students were still talking about the displays while travelling back to school. This indicates an impact beyond just the participation time.
- Middle school teachers were impressed with both the variety and the quality of the presentations.
- Student competitors were typically surprised at their own enjoyment of the event. Most indicated that they were either very nervous about the event or in fact dreading having to interact with middle school students for three hours. However, by the end of the event, their fears had been replaced with a genuine enjoyment of the activity.
- Student competitors were also impressed with the questions they were asked during their presentations.
- The professional educators who helped us judge the event were very impressed both with the quality of the displays and with the overall concept of the event. In fact, they were so impressed that they began discussing how to change the current middle- and high school science fairs to be more like our event.

CONCLUSIONS

The purpose of this paper was to document an extremely successful use of a college student competition as a vehicle for outreach to middle school students. The paper presented information on creating rules, a scoring rubric, and anecdotal evidence of the success of the event. Hopefully, this paper will inspire other universities to use college student competitions as an opportunity for outreach.

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Steven M. Click, PhD, PE

Steven M. Click, Ph.D., PE, is an Assistant Professor at Tennessee Tech University, where he specializes in transportation operations and design research and education. He received his MS and his PhD from NC State University, and he worked for the North Carolina Department of Transportation for seven years primarily in traffic signal and signal system operations. He is a member of ASEE, and has made several presentations at the ASEE-SE Annual Conference, predominantly focused on technology applied to the classroom.