AC 2009-626: WHAT CAN AN ENGINEERING OUTREACH PROGRAM OFFER YOUNG WOMEN THAT THEY CAN'T FIND IN AN ENGINEERING CURRICULUM AT SCHOOL? FUN!

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What Can an Engineering Outreach Program Offer Young Women That They Can’t Find in an Engineering Curriculum at School? Fun!

Since its inception in 2002, the Future Engineers’ Summer Camp (FESC) at The Ohio State University has given more than 200 young women the opportunity to “have fun while learning about engineering” and engineering-related careers (Weavers et al., 2008, p. 3). Originally developed with funding from the National Science Foundation’s Presidential Early Career Award for Scientists and Engineers, FESC has consistently sought to ensure that these young women derived not only knowledge but also enjoyment from their participation in the program. Drawing on quantitative and qualitative data collected by Weavers et al. (2008) during FESC 2006, this paper will argue that the camp’s emphasis on enjoyment, on what the camp organizers have referred to as “having fun,” is what allows this particular outreach program—and others like it—to play a crucial role in increasing the number of women who are interested in engineering and who see this field as offering them viable and compelling career options.

FESC is a five-day, nonresidential summer program for female students who will be entering the eighth grade in the fall following their participation in the camp. Each year, approximately 30 students are accepted to the camp, and admissions decisions are based on an applicant’s written responses detailing her career interests, what she knows about engineering and what areas of the field are of interest to her, and why she wants to attend the camp; a teacher recommendation from the applicant’s current math or science teacher; and a copy of the applicant’s most recent grade report.

The camp is held in August on the Ohio State Columbus campus and runs Monday through Friday, from 9:00 am to 4:30 pm. Each day, participants engage in a series of hands-on activities and interactive demonstrations designed to introduce them to different disciplines within the field of engineering. These activities are led by Ohio State engineering faculty and graduate students, as well as engineering professionals employed throughout the Columbus area. For example, during the 2006 program, a graduate student in the Department of Mechanical Engineering introduced the participants to biomechanical engineering by having them construct their own shoes out of foam and cardstock, while an engineer from the Columbus-based engineering and architectural firm Burgess & Niple engaged the young women in mixing, pouring, and decorating their own concrete stepping stones as part of a series of activities focused on civil engineering. In addition to taking part in activities on the university campus, FESC participants spend at least one day visiting area businesses and corporations, where they also engage in activities and go on tours designed to give them a better understanding of what engineers do in the “real world.” As part of FESC 2006, for example, participants visited The Scotts Miracle-Gro Company and the Nestlé Product Technology Center, both of which are located in nearby Marysville, Ohio.

Each year, the FESC organizers seek feedback from participants on their experiences throughout the week of the camp using three assessment tools: (1) activity evaluation cards, (2) focus-group discussions, and (3) a retrospective evaluation form. It should be noted here that Weavers et al. (2008) presented a statistical analysis of the data from the 2006 activity evaluation cards and the
2005 and 2006 retrospective evaluation forms. Statistical analyses of the quantitative data collected during earlier or later years are not available. Thus, this paper does not seek to make comparisons across years. Instead, the paper draws on the qualitative data collected from the three assessment tools used during the 2006 camp to better understand the results of the statistical analysis completed by Weavers et al. (2008) on the 2006 activity evaluation card data.

During FESC 2006, the participants were given an evaluation card for each session in which they participated and were asked to rate the following components on a scale of 1 to 5: (a) the quality of the activity overall, from “Poor” (rating of 1) to “Excellent” (rating of 5); (b) what the activity taught them, from “Nothing” to “A Lot”; (c) how fun the activity was, from “Boring” to “Super Cool”; and (d) how comprehensible they found the activity leader, from “Hard to Understand” to “Easy to Understand” (see Figure 1). In addition to rating these four components, the participants were encouraged to write any comments or feedback that they had about a particular activity on the back of the activity evaluation card. All responses were anonymous.

During lunch on the last day of the 2006 program, students were divided into groups of 10, and each group participated in a focus-group discussion led by a moderator with whom they had had no prior contact throughout the week of the camp. (For additional information on the focus groups used during FESC 2006, see Weavers et al., 2008.) The questions covered in these discussions were designed to find out how the camp had affected participants’ career plans, their interest in math and science, and their math and science abilities. In addition, the questions asked students to comment on what they had expected to get out of FESC and what knowledge they had gained about engineering and engineering-related careers from participating in the camp. The focus-group discussions were recorded by a scribe who, like the moderator, was unfamiliar to the participants. A tape recorder was used to record these discussions as well.
On the final day of the 2006 program, the students were also invited to complete an anonymous retrospective evaluation form designed to find out how their “knowledge, attitude and aspirations pertaining to various aspects of engineering” had changed due to their participation in FESC (Weavers et al., 2008, p. 9).\(^1\) (For a discussion of retrospective evaluation and why the camp organizers chose to use this assessment tool, as opposed, perhaps, to something like a pre- and post-survey, see Weavers et al., 2008.\(^1\)) In addition, this form collected information on the participants’ schools, academic paths, hometowns, and ethnic backgrounds and also asked students to provide short answers to the following prompts: (a) “The thing I enjoyed most about the Future Engineers’ Summer Camp was,” (b) “The most important thing I have gained from attending the Future Engineers’ Summer Camp is,” (c) “The one thing, if anything, I would change about the Future Engineers’ Summer Camp,” and (d) “Other comments I would like to make.”

A total of 30 young women attended FESC 2006. Over the course of the camp, these students had the opportunity to participate in 27 different activities and to complete an evaluation card for each. In their statistical analysis of the data collected from the 2006 FESC activity evaluation cards, Weavers et al. (2008) noted that “not all of the girls consistently rated each activity which explains the variance in the sample size” (p. 12, see Table 1).\(^1\) This variance could have occurred because camp organizers did not collect all of the evaluation cards for a given activity and/or because participants chose not to submit their evaluation cards. In addition, at least one of the 2006 FESC activities—the BBQ—was optional, which may be why the sample size for this activity is less than 30.

<table>
<thead>
<tr>
<th>Activity</th>
<th>n</th>
<th>Fun</th>
<th>Overall Quality</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the Shoe Fits</td>
<td>25</td>
<td>4.88</td>
<td>4.84</td>
<td>4.08</td>
</tr>
<tr>
<td>Nestlé: Product Development</td>
<td>28</td>
<td>4.79</td>
<td>4.82</td>
<td>4.11</td>
</tr>
<tr>
<td>Waves of Destruction</td>
<td>29</td>
<td>4.79</td>
<td>4.72</td>
<td>4.07</td>
</tr>
<tr>
<td>Hovercraft</td>
<td>22</td>
<td>4.77</td>
<td>4.82</td>
<td>4.68</td>
</tr>
<tr>
<td>Science of Ice Cream</td>
<td>22</td>
<td>4.77</td>
<td>4.86</td>
<td>4.82</td>
</tr>
<tr>
<td>CSI: Environmental</td>
<td>27</td>
<td>4.74</td>
<td>4.81</td>
<td>4.48</td>
</tr>
<tr>
<td>Concrete: Mix, Pour, &amp; Decorate</td>
<td>27</td>
<td>4.59</td>
<td>4.63</td>
<td>4.11</td>
</tr>
<tr>
<td>Biped Robot</td>
<td>28</td>
<td>4.57</td>
<td>4.64</td>
<td>4.46</td>
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<tr>
<td>Breath Mobile</td>
<td>29</td>
<td>4.55</td>
<td>4.52</td>
<td>3.69</td>
</tr>
<tr>
<td>Scotts: Up, Up, &amp; Away</td>
<td>28</td>
<td>4.54</td>
<td>4.50</td>
<td>3.18</td>
</tr>
<tr>
<td>BBQ</td>
<td>17</td>
<td>4.53</td>
<td>4.47</td>
<td>3.35</td>
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<tr>
<td>Nestlé: Sensory Analysis</td>
<td>30</td>
<td>4.53</td>
<td>4.67</td>
<td>4.37</td>
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<tr>
<td>Up, Up, &amp; Away</td>
<td>27</td>
<td>4.52</td>
<td>4.44</td>
<td>2.93</td>
</tr>
<tr>
<td>Airplane Design</td>
<td>28</td>
<td>4.50</td>
<td>4.54</td>
<td>4.64</td>
</tr>
</tbody>
</table>
With regard to fun, the mean rating for all 27 FESC 2006 activities was 2.96 or higher, while the mean rating with regard to how much the activity taught participants was 2.93 or higher (see Table 1). These mean ratings indicate that on average none of the activities bored the participants nor failed to teach the participants something. However, although all of the activities, on average, offered the participants the opportunity to have fun and to acquire knowledge, those activities that were rated the highest on the fun meter were not necessarily the activities that participants perceived as teaching them the most. For example, of the 14 highest ranking activities on the fun meter—all of which have a mean rating of 4.50 or higher—only 8 (57%) of these (i.e., Science of Ice Cream; Hovercraft; Airplane Design; CSI: Environmental; Biped Robot; Nestlé: Sensory Analysis; Concrete: Pour, Mix, and Decorate; and Nestlé: Product Development) are part of the 14 highest ranking activities in terms of knowledge. And, interestingly enough, 3 (21%) of the top 14 activities on the fun meter (i.e., BBQ; Scotts: Up, Up, & Away; and Up, Up, & Away) are actually the lowest ranked activities on the knowledge scale. (It is possible that the BBQ activity, which involved a dinner and discussion with female engineers, and the Scotts: Up, Up, & Away activity, during which the participants flew airplanes they had constructed during the Up, Up, & Away activity, received lower mean participant ratings with regard to knowledge because the participants may not have expected to learn anything during these activities and therefore found it more difficult to evaluate what they did learn.) Indeed, as shown by the statistical analysis of this data completed by Weavers et al. (2008), there was no significant correlation between the participants’ mean ratings of the activities with regard to fun and their mean ratings with regard to what the activities taught them.1

Although there was no significant correlation between the mean ratings for fun and knowledge, Weavers et al. (2008) did find that participants’ mean ratings for the FESC 2006 activities with regard to fun were positively correlated with their mean ratings with regard to the overall quality of the activities.1 This positive correlation is apparent in the fact that 13 (93%) of the 14 highest ranking activities on the fun meter also appeared in the list of the 14 highest ranking activities in

<table>
<thead>
<tr>
<th>Activity</th>
<th>Rank</th>
<th>Mean Fun</th>
<th>Mean Knowledge</th>
<th>Mean Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nestlé: Scale-Up Design</td>
<td>16</td>
<td>4.44</td>
<td>4.56</td>
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<td>Cholera</td>
<td>27</td>
<td>4.30</td>
<td>4.30</td>
<td>3.74</td>
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<td>Parallel Sorting</td>
<td>29</td>
<td>4.14</td>
<td>4.31</td>
<td>3.59</td>
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<tr>
<td>High Voltage Laboratory Tour</td>
<td>28</td>
<td>4.11</td>
<td>4.29</td>
<td>4.25</td>
</tr>
<tr>
<td>Engineering Drawing</td>
<td>29</td>
<td>4.10</td>
<td>4.14</td>
<td>4.07</td>
</tr>
<tr>
<td>Chemical Weapons Clean-Up</td>
<td>29</td>
<td>4.07</td>
<td>4.03</td>
<td>3.83</td>
</tr>
<tr>
<td>Nestlé: Analytical Chemistry</td>
<td>14</td>
<td>4.00</td>
<td>4.29</td>
<td>4.21</td>
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<tr>
<td>Assembly Line Woes</td>
<td>29</td>
<td>3.97</td>
<td>4.24</td>
<td>4.03</td>
</tr>
<tr>
<td>Scotts: Research Plots</td>
<td>26</td>
<td>3.81</td>
<td>4.15</td>
<td>4.19</td>
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<tr>
<td>Self-Healing</td>
<td>29</td>
<td>3.79</td>
<td>3.93</td>
<td>3.79</td>
</tr>
<tr>
<td>Scotts: Greenhouse</td>
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<td>3.69</td>
<td>3.96</td>
<td>4.12</td>
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<tr>
<td>Reinforced Concrete</td>
<td>27</td>
<td>3.52</td>
<td>3.93</td>
<td>4.37</td>
</tr>
<tr>
<td>Scotts: Packaging Lab</td>
<td>26</td>
<td>2.96</td>
<td>3.35</td>
<td>3.77</td>
</tr>
</tbody>
</table>

This table has been adapted from “Table 1: Descriptive Statistics of 2006 Assessment Card Evaluations” found in Weavers et al. (2008, p. 28).1

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1. Statistical analysis of this data completed by Weavers et al. (2008).
terms of overall quality. (See Table 1 for the participants’ mean ratings for the activities with regard to overall quality; the Up, Up, & Away activity was the one activity that appeared in the list of 14 highest ranking activities with regard to fun but not in the list of the 14 highest ranking activities with regard to overall quality.)

It is important to note that Weavers et al. (2008) found no significant correlation between the participants’ mean ratings with regard to what the activities taught them and their mean ratings with regard to the activities’ overall quality. Of the 14 highest ranking activities on the knowledge scale, only 9 (64%) of these activities (i.e., Science of Ice Cream; Nestlé: Product Development; Hovercraft; CSI: Environmental; Nestlé: Sensory Analysis; Biped Robot; Concrete: Mix, Pour, and Decorate; Nestlé: Scale-Up Design; and Airplane Design) are among the 14 highest ranking activities in terms of overall quality. (It should be noted that two of the activities in the top 14 highest ranking activities with regard to overall quality were the BBQ and Scotts: Up, UP, & Away. As mentioned earlier, these two activities may have received lower mean participant ratings on the knowledge scale because students may not have expected to learn anything from these two activities and therefore may have had difficulty evaluating how much these activities taught them). Thus, although the level of fun provided by an activity did correspond with participants’ perception of the overall quality of the activity, how much an activity taught participants did not relate significantly to their perception of its overall quality.

Given that FESC strives to ensure that participants have fun and learn about engineering, how should we interpret the fact that fun, but not knowledge (or learning), is positively correlated with participants’ perception of the overall quality of an activity? Does this mean that if participants feel that an engineering-related activity is fun, then they will have a positive perception not only of the activity overall but also of the area of engineering represented by the activity? And if knowledge is not correlated with participants’ perception of the overall quality of an activity, and of the area of engineering it represents, then do we really need to worry about designing activities that provide participants with an in-depth look at engineering? Would it be better to engage participants in activities where the process of having fun is emphasized over and above the acquisition of knowledge? And if there is no correlation between fun and knowledge, and participants can therefore enjoy an activity without necessarily learning something new, then how much or what kind of information do our activities need to teach participants about engineering? Should our activities seek to offer participants as much information about engineering as possible? Or, would it be as effective for these activities to provide a minimum of engineering-related knowledge in an enjoyable, or fun, context? And, finally, what constitutes a fun context? When we look across the FESC 2006 activities that the participants rated highest on the fun meter, are there recurring features that can help us understand how middle school girls define “fun” and what “having fun” means to them?

The latter questions about what constitutes a fun activity and what it means to have fun are perhaps the ones most readily addressed by the data collected from the FESC 2006 assessments (i.e., the activity evaluation cards, the focus-group discussions, and the retrospective evaluation form) by Weavers et al. (2008). When asked on the retrospective evaluation form what they enjoyed most about FESC 2006, several participants referred in general terms to the “the activities we did,” the “hands on activities,” “the fun activities,” “doing all the experiments,” and the “great hands on experiences.” Other participants answered this question by mentioning
specific activities like “mixing concrete” and “making a hovercraft and eating icecream [sic].”

Taken together, these young women’s responses define a fun activity as one that offers opportunities for physical engagement, for doing something as opposed to passively absorbing information. Indeed, the importance of action to enjoyment—or, having fun—is further underscored by one of the participant’s explanations during a focus-group discussion as to how the camp met her expectations: The participant’s “sister had attended FESC and so she knew a little bit about the camp, but after attending the camp herself, she realized that the camp is a lot cooler because actually doing all the activities.” (Quotes taken from participants’ statements during the focus-group discussions appear in the third person here and throughout this paper because these statements are taken from the scribes’ transcripts of these discussions, which often were written in the third person.)

The crucial role that physical engagement plays in these young women’s definition of what it means to have a good time is apparent in their mean ratings of the FESC 2006 activities with regard to fun. Although the FESC organizers sought to ensure that all 27 activities offered during the 2006 camp were fun and involved hands-on components, the participants’ mean ratings of these activities in terms of fun indicate that they considered some activities to be much more hands-on, much more active, than others. Participants’ mean ratings, as shown in Table 1, ranged from 2.96 (Scotts: Packaging Lab) to 4.88 (If the Shoe Fits) on a five-point scale with 5 (“Super Cool”) being the highest score possible. Looking across Table 1, it is apparent that those activities requiring a greater degree of physical engagement—whether of the hands, the feet, the eyes, the ears, the mouth, and/or the nose—received higher mean ratings on the fun meter. For example, as part of the highest rated activity, If the Shoe Fits, participants worked in pairs to construct a shoe that was both functional (i.e., it could hold their weight) and aesthetically pleasing. To create their shoes, participants had to trace one another’s feet onto a thin piece of foam before cutting out the outline and using cardstock to create prismatic cells that supported the unique characteristics of their feet. Once they had put the parts of their shoes together using hot glue, participants walked around on the shoes to determine whether any changes needed to be made to their designs. They then decorated the shoes before modeling them for the other members of the group. Over the course of this activity, participants were bending over to trace one another’s feet, using their hands to put together and decorate their shoes, and walking around the room to test and model their designs. Except for a brief opening presentation on biomechanical engineering, participants not only were free to talk and to get up from their seats during this activity but also were encouraged to discuss their design ideas with one another and to move about the room to acquire supplies. This activity’s high mean rating on the fun meter suggests that the 2006 FESC participants valued physical engagement, that they equated having fun with the process of doing something with their bodies, be it bending, standing, walking, talking, or manipulating scissors and glue guns.

As with If the Shoe Fits, nearly all of the 14 highest ranking activities on the fun meter—those with a mean rating of 4.50 or higher—engaged participants’ bodies in a variety of ways. The Waves of Destruction activity, which had the second highest mean participant rating on the fun meter along with the Nestlé: Product Development activity, introduced participants to civil engineering by having them use Legos to build coastal structures that they then placed in a wave tank to see if the structures would withstand tsunami-force waves. In addition to talking about and putting together their structures and moving around to get additional Legos, the participants...
had to climb onto stools to position their structures in the wave tank, and they remained perched on these stools to observe the effects of the waves on their designs. During the Hovercraft activity, which took place in a garage located on the university campus, participants constructed hovercrafts out of plywood, plastic sheeting, and shop vacuums. In addition to cutting the pieces of plywood with saber saws, participants had the opportunity to use hammers, a drill, razor knives, and staple guns to build their hovercrafts. Once the hovercrafts were finished, participants took turns riding around on them in the garage. One participant wrote on the back of her Hovercraft activity evaluation card that this activity “was super fun. It was cool actually making something that was off the ground and actually worked.” The emphasis that this participant placed on the relationship between “making something” and having fun is apparent in another participant’s written comment on the Concrete: Mix, Pour, & Decorate activity, during which participants created their own decorative concrete stepping stones: “This was the best activity so far because we got to create something for ourselves or someone we know!” According to their comments, what was fun for these participants was the process of using their bodies to produce a product that they could then operate and/or use themselves.

Both the Biped Robot and Breath Mobile activities also gave participants the opportunity to make or create something that they could then try out or test. For the Biped Robot activity, participants used tinker toys and pencil erasers to construct multi-legged robots that they then tested by seeing which robots would walk down a sloped wooden plank. During the Breath Mobile activity, participants used drinking straws, Lifesavers, paper, and paper clips to create wheeled vehicles that would move when the participants blew on them. Unlike the Waves of Destruction; the Hovercraft; and the Concrete: Mix, Pour, and Decorate activities, however, these two activities required much less physical engagement on the part of the participants. This reduction in physical movement is reflected in these activities’ lower mean participant ratings with regard to fun. It is also important to note here that the Airplane Design activity, which appeared at the bottom of the list of the top 14 highest ranking activities on the fun meter, gave the participants even fewer chances for doing something with their bodies. Although the participants enjoyed using a computer design program to create an airplane, this activity failed to engage them physically: Indeed, they did little more than sit and click on a computer screen.

In addition to the aforementioned activities that required participants to use their hands, feet, and mouths to climb, ride, mix, build, and blow, others of the top 14 highest ranking activities with regard to fun engaged participants’ noses to smell and their tongues to taste. The CSI: Environmental activity invited the participants to use wafting techniques, along other testing procedures such as cold and hot water baths, to identify a series of unknown liquids in a laboratory setting. As one participant pointed out in her comments on the activity evaluation card, what was enjoyable about this activity was the fact that the participants were able “to actually use the products and not just watch.” Like the CSI activity, both the Nestlé: Product Development and the Science of Ice Cream activities encouraged participants to do more than simply observe a procedure or demonstration. During these activities, participants helped to make/decorate and then also to taste chocolate truffles and different kinds of ice cream, respectively. One participant commented on the back of her Nestlé: Product Development activity evaluation card, “They [the truffles] were really cool to decorate and eat. I wish we had more time to eat them.” This participant’s desire to spend more time eating the truffles highlights
the role that physical engagement plays in creating an enjoyable experience for these young women.

It is interesting to note that the Nestlé: Sensory Analysis activity, during which participants tasted different flavors of truffles as part of a sensory discrimination test, received a lower mean participant rating with regard to fun than did the Nestlé: Product Development or Science of Ice Cream activities. This suggests that participants preferred those activities where they not only got to taste different foods but also to do something else, like decorate or help to make them. The FESC participants’ interest in activities that required more, rather than less, physical engagement is apparent in one participant’s critique of the BBQ activity on her activity evaluation card: “You should make it longer and play like volleyball or something.” Although the BBQ offered participants the opportunity to eat, to talk with one another and with female engineers, and to play a bingo game designed to familiarize them with the female engineers’ careers and accomplishments, this participant’s comment suggests that these young women would have preferred the activity to require an even greater level of physical engagement, even if that meant extending the length of the activity itself. Indeed, participants’ feedback on the Scotts: Up, Up, & Away activity, during which the young women went outside on the lawn of The Scotts Miracle-Gro Company and flew the model airplanes that they had built earlier in the week (as part of the Up, Up, & Away activity), indicated that they would have preferred to have more time devoted to those activities that required a high degree of physical engagement. One participant wrote on her Scotts: Up, Up, & Away activity evaluation card, “Too bad we didn’t have more time,” while another participant exclaimed, “That was awesome [sic] I just wish we did it longer.” These comments are important because they not only confirm that greater levels of physical engagement—walking, throwing, running—correspond to a greater degree of fun for the participants but also beg the question as to whether the amount of time devoted to these more “active” activities should be extended in the future.

In contrast to the top 14 highest ranking activities with regard to fun, the 13 activities listed at the bottom of Table 1 offered participants far fewer opportunities for physical engagement and for making something. For example, the Nestlé: Scale-Up Design activity asked participants to complete a series of calculations in order to decide which of two types of equipment they would purchase to manufacture a line of truffles, while the Cholera activity had them use colored pencils to map the 1854 cholera epidemic in London to determine the source of this outbreak. These two activities—like the Engineering Drawing, Nestlé: Analytical Chemistry, and Assembly Line Woes activities, all of which are also part of the list of lowest ranking activities on the fun meter—not only encouraged participants to remain seated in their chairs but also gave them no end product with which to engage physically (i.e., there was nothing to ride, decorate, taste, fly, etc.). The activities related to computer science and engineering (Parallel Sorting, Chemical Weapons Clean-Up, and Self Healing) did require student to move around the room in imitation of the workings of a computer, computer program, or computer system. However, the amount of physical movement was limited, as it was with the tour that the participants took of the university’s High Voltage Laboratory and with the plain concrete beam that the participants used their combined weight to break during the Reinforced Concrete activity. And once again, none of these activities resulted in a product that the participants could have fun with or physically enjoy.
The failure of the lowest 13 ranking activities on the fun meter to engage the participants physically is most evident in the written feedback provided on the back of the Scotts: Research Plots, Scotts: Greenhouse, and Scotts: Packaging Lab activity evaluation cards. These three activities occurred during the participants’ visit to The Scotts Miracle-Gro Company and involved tours of the company’s research plots, mixing fertilizer as a group to pot individual plants for each of the participants to take home with them, and learning about packaging design and testing, respectively. Commenting on the Research Plots activity, one participant complained, “We did not do anything.” This critique was repeated, perhaps by the same participant, with regard to the Green House activity (“We didn’t do anything”) and the Packaging Lab (“We did not do anything”). Although these comments may have been offered by the same participant, they are important, nevertheless, in underlining why these young women found certain of the FESC 2006 activities more fun than others. For these rising eighth-graders, having fun involves more than just sitting at a desk, watching a demonstration, or taking a tour. To have fun, these young women must be physically engaged, and their climbing, sawing, hammering, mixing, and decorating must result in the creation of something that offers them even more opportunities for physical activity.

In addition to making clear the importance of doing something—of physical engagement—to having fun, the participants’ written comments on the activity evaluation cards provide further insight into the finding of Weavers et al. (2008) that there was no significant correlation between the participants’ mean ratings of the FESC 2006 activities with regard to fun and their mean ratings with regard to what the activities taught them.\(^\text{1}\) In her comments on the Concrete: Mix, Pour, & Decorate activity, one participant explained, “This was really cool but I did not learn veerry [sic] much.” A comment on the back of an Up, Up, & Away activity evaluation card contained similar feedback: “fun but I didn’t learn very much.” These two comments suggest that these young women did not necessarily connect having fun with the acquisition of a significant amount of knowledge. A third comment, this time about the Breath Mobile activity, underscores the participants’ ability to enjoy an activity even if they had done it before and likely had been exposed to all the concepts introduced by the activity: “I’ve done this before, but it was a lot of fun.” The lack of correlation between enjoyment and learning and enjoyment and doing something that is wholly new and unfamiliar makes sense in light of the FESC participants’ understanding of what it means to have fun. If physical engagement is the main requirement for having fun during an activity, it matters less how familiar the participants are with the activity and how much the activity seeks to teach them.

The lack of significant correlation between the FESC 2006 participants’ mean ratings of the activities with regard to fun and their mean ratings with regard to how much the activities taught them also reflects these young women’s belief that the acquisition and use of engineering knowledge does not take place in a fun, and physically engaging, context. Commenting during the focus-group discussion about her expectations for FESC, one participant explained that she “expected [FESC] to be boring, but found it to be really fun.” This comment suggests that prior to attending FESC the participants did not associate engineering and engineering-related programs with having fun or doing something enjoyable. Indeed, according to another participant who spoke during the focus-group discussion, she thought that FESC “was going to be not as fun as it is, that it would be more like school with work.” Underscoring this preconceived notion that FESC would be like school, one participant said that she “thought they would be sitting in
classrooms but they did a lot of fun, hands-on stuff that made it more interesting.” This participant’s use of the phrase “sitting in classrooms” makes clear that these young women thought of engineering as offering little or no opportunity for physical engagement. Before coming to FESC, they had assumed that an engineering outreach program would resemble school with, as one participant suggested, “just a couple of activities…and lectures.”

In addition to correcting the participants’ view of engineering as divorced from fun, FESC disrupts their association of this career field with individuals who are different from themselves. According to one participant who shared her expectations for the camp during the focus-group discussion, she “thought FESC would be a nerd camp, but changed mind after first day [sic].” Another participant underscored these young women’s belief that an engineering-related program would attract students who were not like them, claiming that she “expected ‘a bunch of nerds,’ but was proven wrong.”

The crucial role that FESC plays in dissociating engineering and engineering-related programs from inaction and “nerds” is apparent in one participant’s written response to the prompt “The thing I enjoyed most about the Future Engineers’ Summer Camp” on the retrospective evaluation: “Doing all the experiments & meeting people.” Responding to this same prompt, another participant exclaimed that she enjoyed “making friends and meeting new people…!” In fact, out of 27 written responses to this prompt, 12 (44%) included some reference to “meeting other girls,” “meeting new people,” “making new friends,” “meeting…engineers,” and so on. By introducing the FESC participants to other young women and to female engineers who are like them and who do not fit neatly into the “nerd” stereotype, the camp is able to position engineering as a potential career field. Indeed, one participant claimed on the retrospective evaluation that the most important thing she gained from FESC was “a career possibility,” while another indicated that she had “a new understanding of engineers!!!”

According to Weavers et al. (2008), “non-academic goals [of FESC] include allowing the girls to meet female peers with similar interests and experiencing that it is socially acceptable to like math and science (p. 3).” To ensure that each FESC participant has the opportunity to get to know as many of her fellow participants as possible, the camp organizers divide the young women into pairs or small groups before each activity. As the participants move from one activity to another, the pairings and groups to which they are assigned change, enabling each participant to spend a significant amount of time interacting with nearly every other participant across the week of the camp. One participant’s written response to the retrospective evaluation prompt “Other comments I would like to make…” points out how these shifting pairings and groups contribute to the young women’s view of engineering and engineering-related programs as offering a space for fun: “This camp was awsome [sic]. I made a lot of friends.” By giving the participants a chance to talk and laugh with one another in addition to decorating, tasting, smelling, and so on, FESC associates engineering with doing something, with having fun, and also demonstrates the important role that teamwork plays in the professional lives of engineers. As one young woman pointed out during the focus-group discussion when asked to “describe a career in engineering” after having participated in FESC, “engineers connect to other engineers.” Clearly for these young women, the appeal of FESC, and of engineering in general, is the opportunity for connection, for doing something together.
The FESC participants’ expectation that physical engagement (i.e., tasting, smelling, making friends, etc.) would play a minor role in an engineering outreach program reflects the general public’s understanding of what engineering is and what engineers do. According to the Engineer Your Life website, which was created by the WGBH Educational Foundation and the National Academy of Engineering in partnership with the Extraordinary Women Engineers Coalition, “Research reveals that most kids and adults don’t know what engineering is, and if they had to guess, they’d tell you that engineers sit alone at a desk all day doing math problems.” In addition, this same website argues that young women, along with their parents, teachers, and counselors, assume that “engineering is difficult and challenging.” Thus, the general public sees engineering as requiring the acquisition and use of a high degree of knowledge but no physical engagement, which, at least for the FESC 2006 participants, means that engineering has everything to do with school and learning (i.e., “sitting in classrooms”) but nothing to do with having fun and connecting with other young women like themselves.

Pointing to the positive correlation that Weavers et al. (2008) found between the FESC 2006 participants’ mean ratings of the activities with regard to fun and their mean ratings with regard to the overall quality of the activities, one participant claimed during the focus-group discussion that she “thought that FESC would be [a] ‘nerd camp.’ Once at the camp, she really started to get into everything (all the activities) and realized that the camp was fun (engineering is fun).” According to this participant’s statement, the opportunities for physical engagement—for “get[ting] into everything”—were what transformed her view of the camp and of engineering. Thus, walking, running, smelling, tasting, making friends, and so on not only affected the participants’ ratings of the activities on the fun meter but also corresponded with their evaluation of the activities (and engineering) as being better overall. Indeed, one participant responded to the prompt on the retrospective evaluation form about the most important thing she gained from attending FESC, saying, “I have learned what engineers do and I have learned that it can be fun.”

Enjoyment, then, rather than knowledge, was the most important thing that the FESC 2006 participants gained from attending the camp. Because these young women already associated engineering with school and with learning, what mattered to them was finding out that engineering is also about physical engagement (i.e., having fun). Sharing her expectations about the camp during the focus-group discussion, one participant explained, “[I] thought FESC would be like a school day, but more hands on. FESC took it over the top.” By providing an overwhelming number of opportunities for physical engagement, FESC succeeded in convincing the participants that engineering is about more than “sit[ting] alone at a desk all day.” Indeed, when asked on the retrospective evaluation form to indicate on a scale of 1 to 4 (where 1 represents “no,” 2 represents “sometimes,” 3 represents “usually,” and 4 represents “yes”) their “interes[t] in pursuing a degree/career in a science or engineering field” before FESC and then “Now…after [they] have participated in FESC,” the average participant response was 2.75 and 3.43, respectively. This increase in the average participant response from “sometimes” to “usually” is significant in that it reflects how FESC positively affects young women’s views of engineering and engineers. As one participant explained during the focus-group discussion, “Engineers are way cooler than I thought and certainly aren’t nerds, just people like the rest of us.”
FESC’s ability to transform these young women’s understanding of engineering to include both
the acquisition of knowledge and the process of having fun underscores the important role that
outreach programs play in the growth and development of the engineering pipeline. Unlike
schools, which are usually coeducational and where the emphasis is nearly always on the
acquisition of new knowledge over and above the process of having fun, engineering outreach
programs can provide a wide variety of opportunities for young women to do something
together, be it sharing ideas for decorating a concrete stepping stone, constructing a shoe, or
building a hovercraft. In addition, as Yaşar, Baker, Robinson-Kurpius, Krause, and Roberts
(2006) have noted, schools lack the time to devote to engineering, especially the kind of time
required for fun, hands-on activities: “Even when states include DET [design, engineering, and
technology] standards, teachers generally do not teach DET due to the emphasis on math,
reading, and writing as driven by high-stakes standardized testing” (p. 206). The problem for
teachers and schools is also one of knowledge. According to Brophy, Klein, Portsmore, and
Rogers (2008), “many teachers do not have experience with engineering or science contexts” (p.
381). Thus, even if teachers were able to find time to introduce engineering into their
classrooms, many would still lack the knowledge to engage the students in the kinds of activities
offered by university faculty, graduate students, and professional engineers. Along with the
limitations of time and knowledge, schools may also lack the financial resources to purchase
supplies for engineering-related activities. Although outreach programs often operate under
limited and strict budgets as well, these programs are usually built around hands-on activities and
may, therefore, be able to use more of their financial resources for procuring the supplies
necessary to creating a fun environment for learning about engineering.

For now, then, outreach programs like FESC are crucial to increasing young women’s interest in
and excitement about engineering. By devoting the resources of time, expert knowledge, and
money to producing a series of hands-on, engineering-related activities in a single-sex
environment, these programs work to dispel the myth of engineering as a boring, passive,
socially isolating, and male-dominated career and to instill in their young participants a sense
that engineers are women (and men) who do something, who work together to—in the words of
one FESC participant—“make life better, more fun.”

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