Gender Stereotypes Persist in Middle School Students Engaged in Technical Activity
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Abstract

Middle school students who participated in a hands-on electronics activity in boy/girl pairs this spring exhibited gender-stereotypical traits. The activity was conducted by instructors at Illinois Valley Community College as part of a National Science Foundation-funded project designed to increase interest in engineering technology careers by engaging students in science, technology, engineering and math (STEM) activities. In pre activity surveys the girls said they were significantly less comfortable working with tools and building things than the boys. The activity for this study, wiring an LED light or a buzzer, allowed researchers to observe the interactions between the pairs. Interestingly, while most of the students reported that they and their partner shared in the activity equally, observers identified boys dominating in using the tools and assembling the units in the majority of cases. While this study was limited to fewer than 60 students, the results indicate that gender stereotypes do persist and suggest that further research be conducted with hands-on technical activities.

Keywords: STEM, gender study, K-12 outreach

Literature Review

Concern about the insufficient number of young people, and particularly young women, preparing for engineering or engineering technology careers has continued to grow in recent years (National Science Foundation Engineering Task Force, 2005). While research shows perceived difficulty of engineering programs is a barrier to choosing engineering for both young men and young women (South Carolina Advanced Technological Education Center of Excellence, 2000), the major reason young women avoid engineering-related fields is their lack of technical confidence (Thom, Thompson & Hoy, 2001; Extraordinary Women Engineers Project, 2005), which declines by or during the middle school years (American Association of University Women Educational Foundation, 1998; Blaisdell, 2000; Kimmel, Koppel & Muldrow, 2001). Studies indicate that lack of confidence is traceable to experiences outside and inside the classroom. Middle school boys have reported more “prior experience outside of school with a variety of tools and objects” (Jones, Howe & Rua, 2000, p. 185), and boys dominate in activities requiring use of equipment in the science classroom (Tindall & Hamil, 2004; Jovanovic & Dreeves, 1998; Farenga & Joyce, 1997.) Sadker, Sadker and Zittleman (2009, p. 110) note that boys are encouraged to complete hands-on tasks themselves while girls are “short-circuited” by having the hands-on tasks done for them. To improve women’s technical confidence, reports cite the importance of exposure to construction toys (Hill, Corbett & St. Rose, 2010) and of hands-on laboratory experiences (Tindall & Hamil, 2004; Lee & Burkam, 1996; Lee & Burkam, 1997; American Association of University Women Educational Foundation, 2000).
This study of boy-girl pairs was developed to examine if gender stereotypes persist in middle-school-age students potentially impacting hands-on technical activities in the classroom and, eventually, career choices of young women.

Methodology

Sixty students, 30 male and 30 female, from grades six through eight, were randomly selected from two rural middle schools in Illinois to participate in a hands-on engineering-related activity. A total of 58 students participated because one student was absent on the scheduled date. Students were required to work in pairs, one boy with one girl – both in the same grade, to wire either a buzzer or a light emitting diode (LED). The activity involved the use of wire strippers, scissors, electrical tape, batteries, and a buzzer or an LED (See Figure 1 below). The half-hour activity was conducted by Illinois Valley Community College faculty, the authors of this paper.

Figure 1: Parts and tools utilized in wiring a buzzer (at left) and an LED light (at right).

Students were given minimal instructions along with a demonstration of how to complete the task. Anonymous pre- and post-surveys were administered to each student which assessed attitudes and reactions to the activity. For each pair of students, one observer took detailed notes on their interactions (See Figure 2 below). Students were told they would not be graded or timed and that observers were present to take notes on their interactions. Observers were trained on the use of a data sheet (See Appendix) prior to the activity.

Figure 2: Observers record interactions while student pairs work.
Results

Pre surveys revealed girls were significantly less comfortable using tools and building things than the boys. Observations of the pairs in action supported that data, revealing the boys to dominate in the majority of the pairs. Interestingly, most of the students said they participated equally. Statistical details about the pre survey responses, which revealed significant differences at the 99% confidence level between the boys and girls, are in Table I below.

**TABLE I: Pre Survey Responses With Significant Differences Between Boys and Girls**

<table>
<thead>
<tr>
<th>How comfortable are you using tools?</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>9.38*</td>
<td>7.52*</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.82</td>
<td>2.18</td>
</tr>
<tr>
<td>Z statistic</td>
<td>4.29*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How comfortable are you building things?</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.72*</td>
<td>7.52*</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>1.39</td>
<td>2.06</td>
</tr>
<tr>
<td>Z statistic</td>
<td>2.61*</td>
<td></td>
</tr>
</tbody>
</table>

*Significant difference between boys’ and girls’ responses at the 99% confidence level.

Table II, below, presents the Likert scale mean of pre survey responses for boys and girls on all questions.

**TABLE II: Mean Responses to All Pre Survey Statements**

<table>
<thead>
<tr>
<th>Likert Scale of 10 – 1</th>
<th>Boys' Mean (N = 29)</th>
<th>Girls' Mean (N = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How comfortable are you using tools?</td>
<td>9.38*</td>
<td>7.52*</td>
</tr>
<tr>
<td>2. How comfortable are you using computers?</td>
<td>8.72</td>
<td>8.83</td>
</tr>
<tr>
<td>3. How comfortable are you building things?</td>
<td>8.72*</td>
<td>7.52*</td>
</tr>
<tr>
<td>4. How comfortable are you working in a team?</td>
<td>8.34</td>
<td>8.66</td>
</tr>
<tr>
<td>5. How comfortable are you working alone?</td>
<td>7.41</td>
<td>6.90</td>
</tr>
<tr>
<td>6. How comfortable are you working with someone of the opposite gender?</td>
<td>7.66</td>
<td>8.10</td>
</tr>
</tbody>
</table>

*Significant difference between boys’ and girls’ responses at the 99% confidence level.

Table III, below, presents the Likert scale mean of post survey responses for boys and girls. Those responses did not show significant differences.
TABLE III: Mean Responses to Post Survey Statements

<table>
<thead>
<tr>
<th>Likert Scale of 10 – 1</th>
<th>Boys’ Mean (N = 29)</th>
<th>Girls’ Mean (N = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 = Very comfortable</td>
<td>8.59</td>
<td>8.59</td>
</tr>
<tr>
<td>1 = Very uncomfortable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Likert Scale of 10 – 1</th>
<th>Boys’ Mean (N = 29)</th>
<th>Girls’ Mean (N = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 = Lots of fun</td>
<td>8.86*</td>
<td>8.69*</td>
</tr>
<tr>
<td>1 = No fun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. How comfortable were you working on this activity with your partner?
   - Boys’ Mean (N = 29) = 8.59
   - Girls’ Mean (N = 29) = 8.59

2. How much fun was it to work on and complete this project?
   - Boys’ Mean (N = 29) = 8.86*
   - Girls’ Mean (N = 29) = 8.69*

* Students who rated the activity as not much fun (4 and below) and who were uncomfortable working with their partner (4 and below) also rated their contribution to completing the activity as low.

Students reported equal participation in the exercise in much higher numbers than the observers. In the post survey, 47 of the 58 students (84%) said their contribution to assembling the buzzer or light was equal to their partner’s contribution. Observers noted equal tool use in only 6 or 21% of the pairs. Additionally, observers noted 17 of 29 (59%) of the boys were using the tools the majority of the time, and 6 of 29 girls (21%) were using tools the majority of the time.

Qualitative data reported by observers noted that seven of the boys, but none of the girls, started handling the parts and tools as soon as they sat down. When all of the students were seated, they were directed not to handle the parts until after brief instructions. Some boys, but none of the girls, continued to handle the parts, and a couple of the boys began stripping wires after being told not to handle the tools. At least two of the girls advised their partners to put the tools/parts down: one said, “Don’t mess with it yet.” Observers noted that two boys did not connect the wires properly and had to redo the process and/or ask for help probably because they had not listened. Boys were also more likely to handle the buzzer or light, turning it on and off, after it was assembled.

Observers also noted that a few girls looked unsure or unnerved. One girl said, “I have no idea what I am doing.” Another girl told her partner, three times, that she was nervous. Some girls started to strip the wires but when they were unsuccessful, they quickly gave the wire stripper to the boys. Some observers noted girls paying more attention to instructions, more focused on completing the task, and more concerned about safety. Observers also noted girls who were not doing anything and boys dominating the activity.

Of the six pairs (21%) that observers rated as working equally, the observers noted excellent teamwork, which resulted in those students completing the assembly quickly. In one case, the pair wired the LED incorrectly, asked for help, and then rewired the light. The observer noted that those students did not seem bothered by having to do the wiring over, and they were still the first pair to finish.
FIGURE 3: Pairs sharing the assembly equally and exhibiting good teamwork skills.

Discussion

While this study was limited to 29 pairs of middle school boys and girls, the results confirm the findings of earlier studies by indicating that gender stereotypes continue to play a role in classroom dynamics. More specifically, this study indicates that girls continue to lack technical confidence. And in order to increase the number of women preparing for, entering, and continuing in technical STEM fields, gender stereotypes and women’s lack of technical confidence must be addressed. The findings from this study illustrate that:

1. Girls need to be encouraged and assisted in becoming comfortable using tools and building things, even before middle school. Single-gender activities may be the most manageable and efficient way to introduce girls to tools and provide them with opportunities to practice and become confident in using them.

2. When girls and boys are working together, the activity needs to be carefully structured and supervised to ensure equal participation. Additionally, mixed gender activities can be used as a way of incorporating the teaching of teamwork skills.

3. Teachers need to be educated on the importance of and methods for building the technical confidence levels of girls and of structuring hands-on activities for equal participation.

4. Parents and the general public need to be more aware of the impact of gender stereotypes and of the importance of building the technical confidence levels of girls.

5. Further research needs to be conducted on gender stereotypes and technical confidence levels of young women, and the results of that research need to be widely shared.

Conclusion

Despite decades of research and numerous national reports noting that gender stereotypes are a barrier to women considering STEM careers, this study indicates that gender stereotypes persist. Because young girls are socialized to consider traditional careers such as health care and education, which tend to pay less than many STEM career options, positive interventions that
address gender biases early on are essential. Teachers and parents are in the best positions to encourage girls to develop skills in nontraditional activities, such as building and wiring. Engaging young women with tools early on, and educating teachers and parents how to effectively address gender interactions that are detrimental to girls, may help girls improve their self-confidence and their technical skills. As girls fail to make strides in these areas, this dynamic could continue to prevent girls from choosing STEM careers and exacerbate the wage gap that still exists between males and females, including fields where the numbers of women are drastically low, such as engineering and information technology. Because the persistence of gender stereotypes has significant implications for classroom dynamics at every level of education as well as on the recruitment of women into STEM fields, a more concentrated effort at inclusion is necessary if women are to break the glass ceiling that still exists in some areas of STEM.

Acknowledgement

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Appendix

Data Sheet

Observer Name: _____________________________  Date: _____________________________

Middle School _____________________________

To the observer: This activity should take less than 30 minutes. During that time you will be observing both individuals and collecting data on their actions and interaction with each other. Make time estimates using percentages to the best of your ability (i.e. the activity was 30 minutes, one person spent 20 minutes actively engaged in the task through building, talking, or asking questions). Use the space provided to record any qualitative data you observe that is relevant to the activity.

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>Boy</th>
<th>Girl</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check who INITIATED the activity (i.e. picked up equipment, gave direction to start)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity was directed or led by this person (if equal, put 50% in each box; if not, allocate %)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactions between the pair on a scale 1-10 (1=Poor; 10=Superior)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tally # of questions asked by each person</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of time using tool/assembling the unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence or comfort levels of each student. On a 1 – 10 scale (1=not confident/uncomfortable to 10=very confident/comfortable)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please explain any other observations you might have made during this activity. ____________________________________________
________________________________________________________________________________________________________________
________________________________________________________________________________________________________________
________________________________________________________________________________________________________________
________________________________________________________________________________________________________________
________________________________________________________________________________________________________________

*Use the back of this sheet if necessary*
References


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