Gender Differences in Interest, Perceived Personal Capacity, and Participation in STEM-Related Activities

Today, more women than in the past obtain degrees in science and engineering (Dean & Fleckenstein, 2007; Hill, Corbett, & St. Rose, 2010). However, women still remain underrepresented in science, technology, engineering, and mathematics (STEM) (Hill et al., 2010). Why, after so many systemic efforts (Liston, Peterson, & Ragan, 2008; Lufkin & Reha, 2009), do women continue to be underrepresented in STEM? Valian (2007) suggested that fewer females than males pursue professional careers in science due to low interest. Valian hypothesized that since individuals make their own choices, some individuals, regardless of the encouragement or support they receive, remain uninfluenced and do not explore STEM-related career options. Are females just not interested in STEM? Jolly, Campbell, and Perlman (2004) proposed that certain components must be in place to increase the likelihood of females pursuing interests in STEM.

Jolly, Campbell, and Perlman (2004) reviewed research and evaluation efforts, as well as reform efforts, in quantitative disciplines that focused on student success in STEM. Several patterns emerged from the research review, which Jolly et al. categorized into three broad-based themes that created the Engagement, Capacity, and Continuity (ECC) Trilogy. Jolly et al. (2004) noted,

> The underlying assumption of the Engagement, Capacity and Continuity Trilogy (ECC Trilogy) is that these three factors must be present for student success. Each of these factors is necessary but individually is not sufficient to ensure student continuation in the sciences and quantitative disciplines. The factors are interdependent. The absence of one can have an impact on the degree to which the others are present. (pp. 3-4)

This paper gives an overview of student engagement, perceived personal capacity, and continuity, as well as describes the gender-related findings of a study that modified and operationalized Jolly et al.'s (2004) ECC Trilogy. The paper also discusses how the findings of this study can be utilized by STEM teachers to understand possible reasons for low female enrollment in their STEM classes.

The likelihood of student engagement in learning a specific topic increases when they possess an awareness, positive attitude, and interest in the topic (Jolly et al., 2004). Jolly et al (2004) suggested that different types of student engagement occur when learning academic disciples. If students feel their social worth will improve as a result of participating in an academic, social, or

Katherine Weber (tekteach@hotmail.com) is an independent STEM Equity Consultant in Waterloo, Ontario, Canada.

extracurricular activity, they experience behavior engagement (Fredericks, Blumenfeld, & Paris, 2004; Jolly et al., 2004). On the other hand, when students respond positively to the discipline because they find the content itself interesting and intellectually satisfying, they experience emotional engagement (Fredericks et al., 2004; Jolly et al., 2004). Whereas, student interest in mastering concepts that lead to learning more advanced concepts results in cognitive engagement (Fredericks et al., 2004; Jolly et al., 2004). Lastly, students' interest in an activity they find both rewarding and connected to their career goals results in vocational engagement (Fredricks et al., 2004; Jolly et al., 2004). All, or a combination, of these different types of engagement create stronger student interest in the study of an academic area (Jolly et al., 2004).

Students must take prerequisite courses in order to gain an understanding of the advanced content, which in turn increases their capacity for the essential knowledge or skills in an academic area (Jolly et al., 2004). Student motivation increases if they perceive that they can successfully complete a task (Zeldin, Britner, & Pajares, 2008). Therefore, one's level of self-efficacy often acts as a motivator, or not, in pursuing interests in STEM when the task may be difficult (Liu, Hsieh, Cho, & Schallert, 2006; Roue, 2007). If students perceive that they do not possess the necessary math and science knowledge to be successful in a technology and engineering course, they are less likely to enroll in the course (Jolly et al., 2004).

The resources, informal activities, and encouragement or support offered by individuals within a school district create pathways or continuity for students to remain in the STEM pipeline (Jolly et al., 2004). Some researchers have argued that undesirable attitudes and low self-efficacy toward science, technology, engineering, and math negatively influence students' decisions to pursue careers in professional occupations in STEM (Lent, Brown, & Larkin, 1986). However, student involvement in extracurricular activities can be positively linked to their career choices, as well as to their future career goals and plans (Afterschool Allliance, 2009; Chachra, Chen, Kilgore, & Sheppard, 2009).

Methodology

This study employed a descriptive design. The survey responses from students provided measureable evidence to support the use of the ECC Trilogy to identify potential factors related to student interest (or lack of) in becoming an engineer. The research questions were:

1. How do males and females compare with respect to their interest in engagement preferences in technology- and engineering-related activities?
2. How do males and females compare in their perceived personal capacity for doing technology- and engineering-related activities?
3. How do males and females compare in utilizing resources and participating in activities that support STEM-related careers?

4. How do males and females who want to become an engineer compare in their responses within the ECC Trilogy?

Participants

The population for this study included middle school and high school students enrolled in technology and engineering courses in the state of Wisconsin. In order to measure students' interest in becoming an engineer, only students who were enrolled in a contemporary technology and engineering program were invited to complete the survey. The sample included 303 middle school students (grades 6-8) and 253 high school students (grades 9-12), for a total of 556 students. Out of the 556 students who responded, 120 were female middle school students, 48 were female high school students, 183 were male middle school students, and 205 were male high school students.

Instrumentation

This study utilized a modified instrument from the Assessing Women and Men in Engineering Project (AWE) website entitled, Pre-Activity Survey for Middle School-Aged Participants—Engineering (2009). The researcher placed each item of the original survey in a category within the Engagement, Capacity, and Continuity (ECC) Trilogy and subscales. Five national equity experts were asked to confirm the researcher's categorizing of the survey items. Each expert possessed a great depth of understanding about factors that influence females in STEM and were actively involved in systemic projects with a focus on increasing the representation of females in STEM. The experts were also asked to rank the items according to importance. The mean of the expert rankings on each item determined the top five survey items for each of the Engagement subscales (behavior, emotional, cognitive, and vocational); the four subscales were also grouped together to create the Engagement dependent variable. In order to measure whether students looked forward to science class, math class, and technology and engineering class, three additional items were added to the emotional engagement subscale. The top 10 survey items related to the Perceived Personal Capacity variable were also selected for the survey.

In order to measure the Continuity variable, the instrument required some survey items that quantified students' use of resources and participation in programs that nurtured STEM-related interests. An exhaustive list of resources and afterschool programs was given to twenty technology and engineering teachers. The teachers indicated five resources they felt their students were most likely to use and five afterschool programs their students would most likely participate in. The five resources and the five afterschool programs most frequently indicated by the teachers were added to the survey to represent the Continuity variable. One question on the original survey asked students to indicate who encouraged them to pursue engineering as a career. The researcher's dissertation committee requested that one question be divided into two separate questions so that students could identify which people outside of school and which people in school encouraged them to be an engineer.

The modified Technology and Engineering (ECC) Survey included 49 statements that operationalized the Engagement, Capacity, and Continuity (ECC) Trilogy (Jolly et al., 2004) and three demographic questions. The developer of the original instrument felt that a pilot study was not necessary to test the revised instrument because of the minor word changes and reordering of the questions. In order to verify that students could complete and read the survey with ease, 12 students who were 12-13 years old and 10 students who were 14-16 years old completed the survey. Students in each group were asked whether or not they understood what each question was asking and if something should be reworded. A group of 15 middle school students and a group of 10 high school students were also asked to complete the survey online to test ease of use and understanding online. The students in all groups reported that they understood each question on the survey.

Scoring of the Instrument

The instrument included several different types of questions. Survey items 1, 2, and 3 asked students to indicate whether they wanted a career in a technology-related field, or engineering-related field, or whether they wanted to become an engineer on a 4-point Likert scale—1 (*no*), 2 (*don't know*), 3 (*maybe*), and 4 (*yes*). Survey items 4-5 collected frequency data; students were asked to indicate who encouraged them to pursue a career in a technology- or engineering-related field. Survey items 6-23 asked students to indicate their level of interest in technology and engineering activities and work on a 4-point Likert scale—1 (*not interesting at all*), 2 (*not that interesting*), 3, (*somewhat interesting*), and 4 (*very interesting*).

Survey items 24-38 asked students to indicate their level of agreement using a 5-point Likert scale—1 (*does not apply*), 2 (*strongly disagree*), 3 (*somewhat disagree*), 4 (*somewhat agree*), and 5 (*strongly agree*). The *does not apply* was added to accommodate students who may not be enrolled in math or science at the time of the survey. In order to have a similar 4-point Likert scale as the other components in the ECC Trilogy, the responses were recoded to reflect—0 (*does not apply),* 1 (*strongly disagree*), 2 (*somewhat disagree*), 3 (*somewhat agree*), and 4 (*strongly agree*).

Similarly, survey items 39-49 asked students how often in the last year they utilized the resources and participated in activities listed—1 (*1-2 times*), 2 (*3-5 times*), 3 (*more than 5*), 4 (*have not done but would like to*), and 5 (*have not but do not wish to*). In order to include survey items 39-49 in the analysis of the *Continuity* variable, the responses were recoded to reflect a 4-point Likert scale—0 (*have not but do not wish to*), 1 (*have not done but would like to*), 2 (*1-2 times*), 3 (*3-5 times*), and (4) (*more than 5*). Survey items 50-52 were demographic questions. Students were asked to indicate their gender, grade level and the number of technology and engineering classes they have completed.

Data Collection

Prior to collecting data, authorization to conduct the study was requested from the Fielding Graduate University Institutional Review Board (IRB Protocol # 09-2340), and a subsequent modification request, submitted due to dissertation committee recommended changes, was approved. In order to survey students with similar exposure to technology and engineering, the Technology and Engineering Supervisor at the Wisconsin Department of Public Instruction was asked to recommend middle school and high school technology and engineering programs where teachers: (a) were active members of the Wisconsin Technology Education Association, (b) employed a variety of instructional strategies, (c) implemented content within their program that reflected contemporary technology and engineering curriculum, and (d) integrated engineering-related activities into their curriculum. Eight high school teachers and 6 middle school teachers were recommended to participate in the study. An email was sent to the principals of the technology and engineering teachers who were recommended to participate in the study. After permission was granted by the principal, an email invitation to participate in the study was sent to the technology and engineering teacher. Five high school teachers and 5 middle school teachers accepted the invitation for their students to participate in the study. A package that contained the consent and assent forms, survey instructions, and copies of the survey was mailed to each teacher. The survey was also available online for teachers who had lab access. Teachers mailed completed paper surveys and consent and assent forms back to the researcher.

Data Analysis

The independent variables were gender and grade level. The dependent variables consisted of Engagement, Personal Perceived Capacity, and Continuity. The dependent subscales were behavior, emotional, cognitive, and vocational engagement, as well as resources, after-school activities, and encouragement from others. A series of two-way factorial analyses of variance was conducted with the data to examine: (1) possible relationships between male and female middle school and high school students level of interest in engaging in different types of technology- and engineering-related activities and work, (2) possible relationships between male and female middle school and high school students' perceived personal capacity in technology- and engineering-related activities, and (3) possible relationships between male and female middle school and high school students in pursuing pathways created to stimulate interests in STEM fields. The data was also sorted to examine only the students who indicated they want to become an engineer. A series of two-way factorial analyses of variance was conducted with the new data set to examine students' responses within the Engagement, Perceived Personal Capacity, and Continuity variables.

Findings

When examining the Engagement, Perceived Personal Capacity, and Continuity variables separately in this study, most of the results reflect typical gender responses found in past research. Interestingly, when examining the responses of students who indicated they want to become an engineer some patterns emerged that were not gender specific and that support Jolly et al.'s (2004) ECC Trilogy. The following sections will describe the findings for each research question.

Research Question 1

The responses to survey items 6 through 28 on the survey were grouped together to form the dependent variable, *Engagement*. Statistical significance was found between genders ($F(1, 552) = 6.19$, $p = .013$, $\eta_p^2 = .011$). Males (M=3.11, SD = .48) and females (M= 2.98, SD = 50) indicated similar levels of interest in engaging in technology- and engineering-related activities and work (see Table 1). This finding coincides with past research (Weber & Custer, 2005). No statistical significance was found between genders in the behavior subscale (see Table 1); however, the means of both genders suggest that they possess a similar interest in activities that are behaviorally engaging (see Table 1).

Statistical significance was found between genders for the emotional, cognitive, and vocational subscales (see Table 1). Males indicated they possess more interest than females in emotionally engaging activities (see Table 1); this finding contradicts past research (Weber & Custer, 2005). Males also indicated more interest than females in cognitively engaging activities (see Table 1). Typically, males have prior technical and mechanical experience that females may lack (Shanahan, 2006) to complete activities in a technology and engineering classroom setting, which may impact why males find these types of activities more appealing. Not surprising, males indicated a greater interest than females in engaging in vocational work related to technology and engineering (see Table 1, next page).

Table 1
The Means, Standard Deviations, and One-Way Analyses of Variance for the Effects of Gender on the Dependent Variable Engagement and Subscales

	Females (N = 168)		Males (N = 388)				
	M	SD	M	SD	F(1, 552)	p	η_p^2
Engagement	2.98	.50	3.11	.48	6.19	.013	.011
Behavior	3.20	.54	3.22	.53	.14	.705	.001
Emotional	3.03	.66	3.19	.60	.57	.011	.012
Cognitive	2.96	.68	3.15	.65	6.42	.012	.011
Vocational	2.46	.76	2.73	.67	19.54	<.001	.034

Statistical significance was found between genders for eight survey items within three of the engagement subscales (see Table 2). In survey item 13, the females indicated a greater interest than males on work that helps a community; this coincides with past literature (Welty & Puck, 2000) and research (Weber & Custer, 2005). Males indicated greater interest than females in survey items 16, 20, 26, and 28 (see Table 2). However, in survey item 15, males indicated a significantly greater interest than females in work that requires repairing things (see Table 2). These findings support past research that males find technically-related activities or work more interesting than females (Mitts & Haynie, 2010; Weber & Custer, 2005). However, in survey item 17, the means for both genders reflect a lack of interest in agricultural improvements (see Table 2, next page); this again coincides with past research (Weber & Custer, 2005).

Table 2
The Means, Standard Deviations, and Analyses of Variance for the Effects of Gender for Statistically Significant Survey Items within Engagement Subscales

	Females			Males					
	M	*SD*	*N*	*M*	*SD*	*N*	*F*	*p*	η_p^2
Emotional									
13. How interesting is work that allows me to help my community or society.	3.28	.77	168	3.08	.82	388	8.87	.003	.016
26. I look forward to technology and engineering class.	2.87	1.14	168	3.32	1.00	388	16.46	<.001	.029
27. I like to learn to use computer software.	2.67	1.23	168	2.94	1.13	388	8.05	.005	.014
28. I like learning how things work.	2.91	1.21	168	3.33	.95	388	14.89	<.001	.026
Cognitive									
20. How interesting is an activity that allows me to take things apart and try to figure out how it works.	2.74	1.09	168	3.22	.88	388	29.11	<.001	.050
Vocational									
15. How interesting is work that allows me to repair things.	2.45	.97	168	3.12	.94	384	53.70	<.001	.089
16. How interesting is work that allows me to design buildings that use energy wisely.	2.48	1.11	166	2.79	.96	384	15.11	<.001	.027
17. How interesting is work that allows me to design ways to help farmers grow better crops.	2.11	.97	167	2.33	.99	387	5.33	.021	.010
19. How interesting is an activity that allows me to design things that will be used in space.	2.48	1.03	168	2.79	1.00	388	15.63	<.001	.028

Research Question 2

The responses to survey items 29-38 were grouped together to form the dependent variable, *Perceived Personal Capacity*. Statistical significant was found ($F(1, 552) = 17.00$, $p < .001$, $\eta_p^2 = .030$). Males ($M = 2.97$, $SD = .67$) indicated a higher level of perceived personal capacity than females ($M = 2.72$, $SD = .66$). However, this does not actually indicate that males possess a greater capacity in STEM than females; males just perceive that they do (Hill et al., 2010). Many survey items within the Perceived Personal Capacity variable had statistical significance (see Table 3). The mean of the male responses, for all survey items in Table 3, suggests that they perceive they possess a higher capacity in science, math, and technology and engineering than females. These findings were not surprising, as it coincides with past research (Hill et al., 2010).

Table 3
Means, Standard Deviations, Sample Size, and Effects for Survey Items with Statistical Significance within the Perceived Personal Capacity Variable

	Females			Males					
	M	*SD*	*N*	*M*	*SD*	*N*	*F*	*p*	η_p^2
29. Science is easy even when it involves math.	2.69	1.07	168	2.91	.98	387	10.64	<.001	.019
30. Science is an easy subject	2.71	1.08	168	2.91	1.00	387	5.32	.002	.010
31. Math is an easy subject.	2.65	1.20	168	2.98	1.00	385	9.17	.003	.016
32. Technology and Engineering is an easy subject.	2.72	1.07	168	3.19	.86	388	24.27	<.001	.042
33. Technology and Engineering is easy even when it involves math.	2.55	.97	168	3.02	.93	388	21.61	<.001	.038
34. Solving design problems is easy in Technology and Engineering.	2.57	.97	167	2.84	.92	388	9.29	.002	.017
36. I can use what I know to design and build something mechanical that works.	2.68	1.05	168	3.05	.88	386	23.07	<.001	.040

Research Question 3

The responses to survey items 39-49 were grouped together to form the dependent variable, *Continuity*. No statistical significance was found ($F(1, 552) = 1.25$, $p = .265$). Males ($M = 2.11$, $SD = .71$) and females ($M = 2.10$, $SD = .69$) indicated a similar use of resources and participation in afterschool activities. Survey item 42, "asked a counselor about engineering as a career," was the only survey item within this variable that was statistically significant ($F(1, 552) = 15.05$, $p < .001$, $\eta_p^2 = .027$). Males ($M = 2.20$, $SD = 1.25$) seem to feel more comfortable than females ($M = 1.77$, $SD = 1.08$) with asking counselors about engineering. Although there was no statistical significance found in survey item 48, females ($M = 2.01$, $SD = 1.18$) indicated they participated more often than males ($M = 1.84$, $SD = 1.14$) in a Science Fair. In regards to encouragement received by others to pursue engineering as a career, males (79.3%) and females (73.8%) reported being encouraged by their technology and engineering teachers. On the other hand, only 20 males and 10 females reported being encouraged by guidance counselors. In regard to people out of school, males (57.5%) reported a higher incidence of being encouraged by their parents or guardians than females (48.8%).

Research Question 4

In order to provide support for the ECC Trilogy, the dataset was sorted to only examine the responses of students who indicated "yes," they were interested in engineering as a career. Using the sorted dataset, a series of two-way between-groups analyses of variance was conducted to explore the impact of gender and school level (middle school and high school) on student Engagement, Personal Perceived Capacity*,* and Continuity*.* No statistical significance was found between genders for Engagement ($F(1, 123) = .21$, $p = .65$), Perceived Personal Capacity ($F(1, 123) = .01$, $p = .911$), or Continuity ($F(1, 123) = 1.25$, $p = .265$). However, the mean responses (see Table 4) of both genders for each of the dependent variables provide quantitative support for the ECC Trilogy. Overall, both genders indicated a high interest in engaging in technology and engineering activities and work, a high level of perceived personal capacity, and an interest in utilizing resources or participating in activities related to STEM.

Table 4
Means, Standard Deviations, and Sample Size of the Dependent Variables for Students Who Want to Become an Engineer

	Females (n = 20)		Males (n = 107)	
	M	*SD*	*M*	*SD*
Engagement	3.20	.74	3.28	.37
Perceived Personal Capacity	3.17	.85	3.27	.51
Continuity	2.10	.73	2.11	.65

Discussion

The purpose of this study was to identify whether the ECC Trilogy could be utilized by teachers in technology and engineering program setting to examine their students' interest (engagement), perceived personal capacity (capacity), and participation (continuity) in technology- and engineering-related activities. The ECC Trilogy provides a practical framework that can potentially assist teachers in identifying what factors create barriers to students wanting to become an engineer or pursuing a career in a technology- or engineering-related field. In order to identify where a lack of interest may occur, this study compared male and female middle school and high school students' responses to STEM-related survey questions that were coded to reflect each component of the ECC Trilogy.

The results within the Engagement variable provide valuable feedback for what types of activities may be interesting to both males and females. The activities completed in many STEM classrooms often foster the interests of males and deter the interests of females (Bachman, Hebl, Martinez, & Rittmayer, 2009). According to the findings of this study, traditional technology education activities that focus on technical or mechanical concepts will most likely not appeal to females, and, in turn, females will choose not to enroll in subsequent technology- and engineering-related courses (Ross, 2011). However, when technology and engineering teachers incorporate engaging, real-life activities, the interests of both males and females will be engaged (Mitts & Haynie, 2010; Weber & Custer, 2005).

Within the Engagement subscales, several findings should be highlighted. Male students indicated a greater interest in activities that are mechanical or technical in nature, which coincides with past research (Mitts & Haynie, 2010; Weber & Custer, 2005). Males often possess more experiences that have equipped them with greater technical competence than females (Shanahan, 2006); as a result, males' prior experience and greater technical competence may influence their interest level to be higher than females in mechanically-related activities (Hill et al., 2010) and in attending technology and engineering courses. Male students also indicated a higher level of cognitive interest in technology and engineering activities than female students in this study. At a very young age, males have been given more opportunities to exercise their spatial skills through manipulative toys and to excel in these types of activities (Bachman et al., 2009; Hill et al., 2010). Additionally, males in this study indicated a higher level of interest in activities that were vocationally engaging, especially when related to fixing or repairing thing, than females. Although this finding coincides with past research (Weber & Custer, 2005), the responses from this study reflect females are not interested in activities related to work or careers in technology- and engineering-related fields.

Frome et al. (2002) proposed that females keep from entering traditionally male dominated fields because females feel they do not possess strong academic ability in math, and they do not possess an interest in math and physical science. In this study, males indicated greater levels of perceived personal capacity in technology- and engineering-related activities than females; this does not necessarily mean that their capacity in STEM is greater (Hill et al., 2010). STEM fields have often been stereotyped to be masculine fields. Teachers should provide STEM-related afterschool events/activities that specifically target female students. In this study, students who reported a high level of perceived personal capacity also indicated that they participated in, or wanted to participate in, afterschool STEM-related activities or events. This finding supports the notion that if teachers create informal opportunities to strengthen students' scientific and technical skills in STEM-related areas (Katehi, Pearson, & Feder, 2009), their attitudes towards STEM may become more positive (Bouvier & Connors, 2011; Singer, 2010; Weber, 2011) and their sense of self-efficacy in engineering-related activities may increase (Bouvier & Connors, 2011; Marra, Shen, Rodgers, & Bogue, 2009; Paulsen & Bransfield, 2009).

Most females in this study did not want to become an engineer; however, they may have based their decision on stereotypes of what engineers do. Females may change their attitudes and at least consider the possibility of pursuing a career in engineering (Bouvier & Connors, 2011; Lufkin & Reha, 2009; Weber, 2011) after they participate in informal engineering-related activities that strengthen their scientific and technical skills and knowledge (Katehi, Pearson, & Feder, 2009). Past research has found that females' attitudes and interest in STEM-related fields can change as a result of their participation in afterschool activities (Paulsen & Bransfield, 2009; Weber, 2011).

Recommendations for Practice

The ECC Trilogy can be utilized by STEM Teachers to identify why females may not be enrolling in their classes. In order to engage females, teachers should examine their curriculum and implement a variety of activities that would interest both males and females. If females do not perceive that they have the capacity to be successful in STEM classes, teachers should provide learning opportunities that allow students to develop skills or acquire knowledge they perceive they do not possess. STEM teachers should become familiar with the various ways students' STEM interests are supported in the school and community and disseminate information about informal STEM-related activities or programs. STEM teachers should also provide counselors, as well as parents, with up-to-date information on the workforce needs related to STEM careers and the benefits of encouraging both males and females into these fields.

Recommendations for Future Research

This study has potential to be replicated in a number of different venues. The study could be replicated: (a) to compare responses from students who are not enrolled in technology and engineering courses with students who are enrolled in technology and engineering courses, (b) in other states or another country to see if similar findings occur that support the ECC Trilogy, (c) by teachers within their school to identify components of the ECC Trilogy that may impact female students' decisions to enroll in technology and engineering courses.

Conclusion

The purpose of this study was to operationalize Engagement, Capacity, and Continuity (ECC) Trilogy so that technology and engineering teachers can identify possible factors effecting female students' decisions to enroll in technology and engineering courses. The student responses from this study provide evidence to support the ECC Trilogy. Both female and male students who indicated that they wanted to pursue engineering as a career responded to the survey items with a high interest in the activities, the belief that they possessed a high perceived personal capacity, and an interest in participating in technology- and engineering-related areas.

Out of 388 males, only 107 (28%) indicated they wanted to become an engineer; however, out of 168 females who participated in the study, only 20 (11.9%) indicated they wanted to become an engineer. More than twice as many males than females indicated an interest in becoming an engineer. This finding should draw some concern especially with the rise in the number of individuals and organizations who invest efforts in increasing female representation in STEM (Hill et al., 2010; Lufkin & Reha, 2009; Marra, Shen, Rodgers, & Bogue, 2009). Positive influences on young people can influence their interest and success in science and math; however, the extent of the influence depends on whether the students' academic motivation, beliefs concerning their abilities, and capacity to succeed in science and math become strengthened (Larose, Ratelle, Guay, Senecal, & Harvey, 2006). Although several researchers have suggested that females may not be interested in engineering-related careers (Hill et al., 2010; Weber & Custer, 2005), STEM equity experts, teachers and post-secondary faculty must continue to collaborate efforts and share successful strategies to encourage females to enter STEM fields.

References

Assessing Women and Men in Engineering Project (2009). Pre-activity survey for middle school-aged participants—Engineering. Retrieved April 27, 2010 from https://www.engr.psu.edu/AWE/

Afterschool Alliance. (2009). *Afterschool innovations in brief focusing on older youth*. Washington, DC: Author.

Bachman, K., Hebl, M., Martinez, L., & Rittmayer, A. (2009). Literature overview: Girls' experiences in the classroom. SWE-AWE CASEE Overviews. Retrieved April 27, 2010 from https://www.engr.psu.edu/AWE/

Bouvier, S. & Connors, K. (2011). *Increasing student interest in science, technology, engineering, and math (STEM): Massachusetts STEM pipeline fund programs using promising practices*. University of Massachusetts Donahue Institute: Hadley, MA.

Chachra, D., Chen, H., Kilgore, D., & Sheppard, S. (2009). *Outside the classroom: Gender differences in extracurricular activities of engineering students.* Paper presented at the 39th ASEE/IEEE Frontiers in Education Conference, October 18-21, San Antonio, TX.

Dean, D., & Fleckenstein, A. (2007). Keys to success for women in science. In R. Burke & M. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 28-44). Northampton, MA: Edward Elgar Publishing.

Fredericks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*, 59-109.

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics.* Washington DC: American Association for University Women.

Jolly, E., Campbell, P., & Perlman, L. (2004). *Engagement, capacity, and continuity: A trilogy for student success*. Minneapolis, MN: GE Foundation.

Katehi, L., Pearson, G., & Feder, M. (2009). *Engineering in K-12 education: Understanding the status and improving the prospects*. Washington, DC: National Academy of Engineering and National Research Council.

Lent, R., Brown, D., & Larkin, K. (1986). Relation of self-efficacy expectations to academic performance and perceived career options. *Journal of Counseling Psychology, 31*, 356-362.

Liston, C., Peterson, K., & Ragan, V. (2008). *Guide to evaluating promising practices in informal science, technology, engineering, and mathematics (STEM) education for girls*. Seattle, WA: Puget Sound Center for Teaching, Learning and Technology.

Liu, M., Hsieh, P., Cho, Y., & Schallert, D. (2006). Middle school students' self-efficacy, attitudes, and achievement in a computer-enhanced problem-based learning environment. *Journal of Interactive Learning Research*, *17*(3), 225-242.

Lufkin, M. & Reha, L. (2009). *Nontraditional career preparation: Root causes and strategies*. Cochranville, PA: National Alliance for Partners in Equity.

Marra, R., Shen, D., Rodgers, K., & Bogue, B. (2009). *Leaving engineering: A multi-year single institution study*. Paper presented at the annual meeting of the American Educational Researcher's Association, April 13-19, San Diego, CA.

Mitts, C. & Haynie, W. (2010). Preferences of male and female students for TSA competitive events. *Technology and Engineering Teacher*, *70*(1), 19-26.

Paulsen, C. A. & Bransfield, C. P. (2009). "*Engineer Your Life" evaluation report for year 2.* In support of NSF 0550710. Concord, MA: Veridian insight, LLC.

Ross, M. (2011). *PK-12 Counselors knowledge, attitudes, and behaviors related to gender and STEM*. Purdue University: Lafayette, IN. Retrieved from http://meaganross.com/mr/wp- content/uploads/2011/01/mross_ 20101213_edci618_study.pdf

Roue, L. (2007). *Young women's perceptions of technology and engineering: Factors influencing their participation in math, science and technology*. Menomonie, WI: University of Wisconsin-Stout**.**

Shanahan, B. (2006). The secrets to increasing females in technology. *The Technology Teacher*, *66*(2), 22-23.

Singer, K. D. (2010). Student attitudes toward science as a result of teacher feedback (Master's thesis). Bowling Green, OH: Graduate College of Bowling Green State University. Retrieved from http://etd.ohiolink.edu/

Valian, V. (2007). Women at the top in science – and elsewhere. In S. Ceci and W. Williams (Eds.). *Why aren't more women in science: Top Researchers debate the evidence* (pp. 27-37). Washington DC: American Psychological Association.

Weber, K. (2011). Role models and informal STEM-related activities positively impact female interest in STEM. *Technology and Engineering Teacher, 71*(3), 18-21.

Weber, K. & Custer, R. (2005). Gender-based preferences toward technology education content, activities, and instructional methods. *Journal of Technology Education*, *16*(2), 55-71.

Zeldin, A., Britner, S., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching*, *45*(9), 1036-1058.