Social Cognitive Career Factors and Students' Interest in Electronics and Engineering (Fundamental)

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Research has shown career development begins in early childhood (Magnuson & Starr, 2000, Trice & McClellan, 1994) and to promote careers in STEM, children must be exposed to the range of available STEM careers at a young age (van Tuijl and van der Molen, 2015). The theory of circumscription and compromise (Gottfredson, 1981), suggests that as children age, they gain the ability to make critical assessments of job-self compatibility and develop a view of acceptable occupations based on self-assessments. Gottfredson (1981) argued that the first occupations eliminated are those perceived to be inappropriate for one's gender, followed by occupations with low prestige and those that require extreme effort. These critical assessments can occur as early as age 5. In a review of children's career development research Watson and McMahon (2005) not only discuss the influence of society on children's career development and gender stereotypes, but the potential increase of that influence over time (Tremaine, Schau, and Busch 1982, Jordan 1976, Liben, Bigler, and Krogh, 2001).

Because critical assessments are occurring so early in childhood, van Tuijl and van der Molen (2015) maintained that male and female STEM role models are particularly important for children. Holmes, Gore, Smith, and Lloyd (2017) studied children ages 8-18 and found an increase in STEM interest for students who have a parent working in a STEM occupation. They suggest that those without a parent working in a STEM field are left with teachers and school guidance counselors to promote STEM careers in order to foster an interest.

Grounded in Bandura's (1977) social cognitive theory, social cognitive career theory (SCCT) focuses on three primary mechanisms that drive career decisions: self-efficacy, outcome expectations, and goals (Lent, Brown and Hackett, 1994). *Self-efficacy* is defined as perceived capability to perform a behavior (Williams, 2000). An *outcome expectancy* is defined as "a person's estimate that a given behavior will lead to certain outcomes" (Bandura, 1977) *Goals* refer to future outcomes that are envisioned such as obtaining employment or finding a career. Researchers are increasingly measuring these factors after an intervention, such as exposure to an engineer or after a science camp, as a mechanism to assess program impacts (Larose, Ratelle, Guay, Senecal and Harvey 2006, Rivale et al., 2011, Douglas, Mihalec-Adkins, and Diefes-Dux, 2014).

Gender differences have been documented in career interests for science and engineering, but studies that look at specific engineering disciplines such as electrical engineering and power electronics have not been as thoroughly researched (Miller, Slawinski Blessing, and Schwartz, 2006, Wang, Eccles, and Kenny, 2013). Career opportunities these fields are growing with advancements in technology. The present study examines young students' perceptions, of not only engineering careers broadly, but also how students perceive career opportunities in electricity and energy fields. This study explored the following research questions:
1) Are there gender differences in engineering and electricity/energy career interests for youth in grades 4-6?
2.) Does an interest in engineering correlate with career aspirations in engineering or career aspirations related to energy and electricity?

3.) Do the factors of self-efficacy, outcome expectations, interests, and goals predict career interest in engineering?

Methods

The study participants were youth who participated in a STEM outreach program held outside of school. The programs included summer camps and after school STEM programs. Students in this study included 1979 students (1043 male and 936 female) in grades 4-6 (see Table 1).

Table 1. *Participant frequencies by gender and racial/ethnic group*

	Gender Identity		
Racial/Ethnic Identity	Male	Female	Total
American Indian/Alaska Native	54	34	88
Asian	56	64	120
Black/African American	195	226	421
Native Hawaiian / Other Pacific Islander	4	5	9
White / Caucasian	566	438	1004
Hispanic / Latino	84	62	146
Multiracial	44	73	117
Other	40	34	74
Total	1043	936	1979

Instrument

Participants completed the Student Attitudes toward STEM (S-STEM) survey, developed by the Friday Institute for Educational Innovation (2012), assessing attitudes toward science, technology, engineering and mathematics as well as postsecondary pathways and career interests. The S-STEM survey was validated and found to be reliable with this sample of participants (Friday Institute for Educational Innovation, 2012, Unfried, Faber, Stanhope & Wiebe, 2015).

Students completed the S-STEM assessment and for the present study, specific sections of the S-STEM instrument were utilized. These sections included items related to engineering and technology attitudes, 9 five-point Likert scale items, as well as two career examples, engineering and energy/electricity, from the "Your Future" section detailing categories of STEM career fields.

Data Analysis

Engineering and Technology questions were categorized, using the constructs of social cognitive career theory: self-efficacy (e.g., "I believe I can be successful in engineering") of which there were two questions, outcome expectations (e.g., "If I learn engineering, then I can improve things that people use every day") with two questions, goals (e.g., "I want to be creative in my future jobs") with two questions, and interests (e.g., "I am interested in what makes machines work") which included three questions. The maximum subscores for self-efficacy, outcome expectations, and goals were 10 and for interest the maximum score was 15.

Chi-square tests were used to determine if an association between gender and interests in engineering and energy and electricity careers was present. Logistic regression was used to determine the effects of self efficacy, outcome expectations, goals and interests on the likelihood that students have an interest in pursuing a career in engineering or energy and electricity.

Results

Students reported being more interested in an engineering career than in specific careers related to energy and electricity (See Table 2). Females were less interested in engineering careers as well as energy/electricity careers than their male counterparts.

Table 2
Students reporting to be "very interested or interested" in selected careers

Career	Male n=1043		Female n=938		All N=1981	
	Frequency	%	Frequency	%	Frequency	%
Energy/Electricity: People invent, improve and maintain ways to make electricity or heat. They also design the electrical and other power systems in buildings and machines.	788	75.5%	484	51.6%	1272	64.2%
Engineering: People use science, math and computers to build different products (everything from airplanes to toothbrushes). Engineers make new products and keep them working.	906	86.9%	617	65.7%	1523	76.9%

Chi-square tests for independence were conducted between gender and interests in engineering careers as well as energy and electricity careers. There was a statistically significant relationship between gender and interests in engineering careers, $\chi^2(1) = 124.174$, $p = .001$, as well as a statistically significant association between gender and interest in energy and electricity careers, $\chi^2(1) = 124.162$, $p = .001$. Female students were less likely to show an interest in these careers than male students.

A logistic regression was conducted to determine the effects of self efficacy, outcome expectations and goals on the likelihood that students have an interest in pursuing a career in engineering. Linearity of the continuous variables with respect to the logit of the dependent variable was assessed via the Box-Tidwell (1962) procedure. A Bonferroni correction was applied using all seven terms in the model resulting in statistical significance being accepted when $p < .007143$ (Tabachnick & Fidell, 2007). The logistic regression model was statistically significant, $\chi^2(3) = 565.633$, $p < .0005$. The model explained 37.6% (Nagelkerke R^2) of the variance in career interest and correctly classified 81.9% of cases. Sensitivity was 94.6%, specificity was 39.5%, positive predictive value was 83.9% and negative predictive value was 68.8%. From these results, outcome expectancy and self efficacy (p=.0001) added significantly to the model/prediction, but goals (p = .613) did not add significantly to the model (Table 3).

Table 3
Summary points for logistic regression (Career interest in engineering and SCCT factors)

							95% C.I. for EXP (B)	
Variables	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Goals	-.025	.050	.255	1	.613	.975	.883	1.076
Outcome	.387	.048	64.016	1	.000	1.473	1.340	1.620
Self Efficacy	.558	.045	152.584	1	.000	1.747	1.599	1.908
Constant	-5.336	.405	173.400	1	.000	.005		

It is important to note the results of this study are limited by this sample of youth, who were all engaged in a STEM outreach program and may not be representative of youth broadly.

Discussion

The significant gender differences seen for interest in careers in engineering as well as energy and electricity are further evidence that gender related interests are developed in childhood and early adolescence. Programs that are designed to promote STEM career interest should begin in the elementary grades to impact these initial career interests prior to students' critical assessments of the career. It is not fully known whether or not career interest remain stable or whether they fluctuate across development. Furthermore, it is not known whether or not youth have a full understanding of what careers in fields such as engineering or energy entail, although a description of careers was included in the instrument. There is a need for the finding that females report less interest than males for engineering and electricity/energy careers, despite numerous calls to action for females in STEM careers.

The results shown in this study found perceptions of careers in energy/electricity were less desirable to youth than engineering careers more broadly. Further research is needed to determine how students view these fields and why these specific areas are less desirable than engineering. One possible intervention could be the use of role models for elementary grade students to provide positive reinforcement for underrepresented students and promote STEM careers for all students. There has been a call for more engineers in electronic engineering and energy research and development (BLS, 2017) and these findings suggest additional efforts may be needed to interest youth in these careers.

The regression results support the factors identified by sociocultural career theory as factors that contribute to career interest. For these youth, outcomes, interest and self efficacy were significant factors that predicted career selection. This suggests that efforts to build knowledge, interest and confidence to successfully do work in these fields may be effective in promoting career interests. These results confirm the Lent, Brown, and Hackett (1994) model, but the findings indicated that goals were not significantly related to career choices in this study. One interpretation is that goals could be linked to outcome expectancy and interest and questions we identified as "goal" questions may have overlapped with other constructs. In depth qualitative investigations in the form of follow up interviews could help to determine the extent of this overlap.

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