2015 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES
S.T.E.A.M. & EDUCATION JUNE 13 - 15, 2015
ALA MOANA HOTEL, HONOLULU, HAWAII

S.T.E.A.M & EDUCATION PUBLICATION:
ISSN 2333-4916 (CD-ROM)
ISSN 2333-4908 (ONLINE)

EXPLORING GENDER DIFFERENCES IN STEM CAREER ASPIRATIONS AMONGST MIDDLE SCHOOL STUDENTS

DECOITO, ISHA
WESTERN UNIVERSITY, CANADA
FACULTY OF EDUCATION

Dr. Isha DeCoito
Faculty of Education
Western University, Canada.

Exploring Gender Differences in STEM Career Aspirations Amongst Middle School Students

Synopsis:

This paper focuses on data collected as part of a larger longitudinal mixed-methods study exploring the impact of outreach workshops on students' attitude and interest in STEM education. Findings highlight gender differences in STEM career aspirations amongst grade 6, 7 and 8 students.

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Introduction and Objectives

In many countries including Canada, students have not demonstrated significant gains in math and science. In 2007, based on PISA results and other factors, the Conference Board of Canada determined that Canada's participation in science, technology, engineering, and mathematics (STEM) education at the postsecondary level is awarded a "C" grade, centered on Canada's relatively low proportion of graduates in these fields (Conference Board of Canada, 2013; Mishagina, 2012; Orpwood, Schmidt, & Jun, 2012). Moreover, male and female participation in areas related to STEM continue to demonstrate a gender disparity, especially prevalent in science and engineering fields. In 2011, men represented the majority (67.4%) of adults aged 25 to 64 with STEM degrees at the university level. The gender disparity continues in STEM graduates, with similar trends evident in the United States (Milgram, 2011).

Many movements have been initiated to generate more interest in STEM. For example, there has been widespread support for outreach initiatives and informal learning opportunities focusing on STEM enrichment (Alexander, Johnson, & Kelley, 2012; Maltese & Tai, 2011). Outreach programs such as science camps and clubs provide valuable experiences that ignite interest and demonstrate how math, technology, engineering and science connect to everyday life and careers, and allow students to expand their skills (Thomasian, 2011).

The goal of this research is to understand the effectiveness of an outreach program in terms of demonstrating efficacy in particular contexts and populations. Specifically, this research explores the effectiveness of the outreach program in terms of its potential to affect STEM interest and attitude in the early grades and beyond, as well as develop 21st century skills through half-day workshops, guided by the passion and knowledge of scientists and engineers. This paper focuses on gender differences in career aspirations amongst middle school students.

Theoretical Framework

The under-representation of women in STEM fields has its origins in early grades (Buchman & DiPrete, 2006; Tan, Barton, Kang, & O'Neil, 2013), since the supply pipeline for university graduates in science and engineering begins in elementary school when children are exposed to and formulate opinions about mathematics and science (Natural Science and Engineering Research Council of Canada (NSERC), 2010). Females are consistently under-represented in STEM majors and careers in most industrialized countries around the world (Blickenstaff, 2005) and several reasons have been proposed for a female deficit within STEM fields, including: (a) stereotypes in science (Hill, Corbett, & Rose, 2010); (b) developed sex-specific skills and interests (Phipps, 2007); and (c) girls' poor attitude toward science and a lack of positive experiences with science in childhood (Blickenstaff, 2005). Rittmayer and Beier (2008) maintain that girls' confidence in their academic abilities drops dramatically from elementary to high school. This decline is particularly significant in girls and young women's belief in their math and science abilities. Varying research indicates that gender differences in interest and self-concept significantly affect the choice to pursue STEM related studies and careers, as well as performance in STEM (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). Hence, the question is how to persuade females to remain in the pipeline and maintain their self-esteem in the sciences.

NSERC (2010) addresses some of the possible measures that can be taken to increase the number of women in STEM fields including: (a) educating females on the successes of other females in STEM areas to promote role models and support self-esteem; (b) creating supportive programming and collaborating community partnerships with hands-on STEM activities (Fox, Sonnert, & Nikiforova, 2009); (c) having positive role models in STEM fields that females can personally talk and relate to in male dominated workplace culture (Vrcelj & Krishnan, 2008); (d) teaching STEM using "gender-sensitive pedagogy" and downplaying masculine competition in the place of collaboration through group projects and oral discussion (Zhao, Carini & Kuh, 2005); and (e) considering not only women in science, but also women and science. Sustained efforts rather than short-term fixes are required with explicit goals, implementation plans, and quantitative and qualitative evaluations of processes as well as outcomes, bearing in mind that

initiatives are likely to falter along the way, given the complex processes involved in knowledge production (Bebbington, 2002).

Outreach programs are proving to have a positive effect on STEM interest and can support young people to (i) develop increased interest and productively engage in STEM and STEM learning activities, (ii) value the goals of STEM and STEM learning activities, and (iii) develop an appreciation of the world of science and consider future STEM pathways.

Methodology

A mixed-methods design (Mills, Durepos, & Wiebe, 2010) was utilized for this longitudinal study to help meet the overall aim of the project and answer specific research questions related to STEM outreach. The study utilized the Middle School (6-8th) Student Attitudes toward STEM Survey (S-STEM) which has been validated and tested for reliability through the National Science Foundation (Erkut & Marx, 2005). S-STEM consist of Likert-scale questions probing students' confidence and attitudes toward math, science, engineering and technology, and 21st century learning respectively. Final items in the surveys explore students' attitudes toward 12 different STEM careers. The larger study includes teachers, students, and administrators from 83 grade 6, 7, and 8 classrooms (approximately 1980 students and 57 teachers) in 4 schools in a local school board in Canada. Sources of data for Phase I included teacher and student STEM surveys; workshop observations; and student reflections on workshops. Surveys were administered at the beginning and end of the school year. Survey data were analysed using ANOVA and descriptive statistics in SPSS. This paper focuses on Phase I of the longitudinal study and includes student pre-post survey data exploring career aspirations amongst middle school students.

Findings

STEM Careers

Students were asked to indicate their level of interest in each of 12 STEM career areas. Level of interest was gauged on a four-point scale, from Not at all Interested (1) to Very Interested (4). Histograms displaying students' interest level in each of the 12 careers are illustrated in Figures 1and 2 respectively. On the pre-survey, students indicated they were most interested in

engineering or computer science careers. Students were least interested in environmental and veterinary work. On the post-survey, students were still mostly interested in engineering, but less interested in environmental work than veterinary work. Overall, students' interest in STEM careers decreased over time. Students' interest in careers in medicine decreased the least, and interest in environmental work decreased the most.

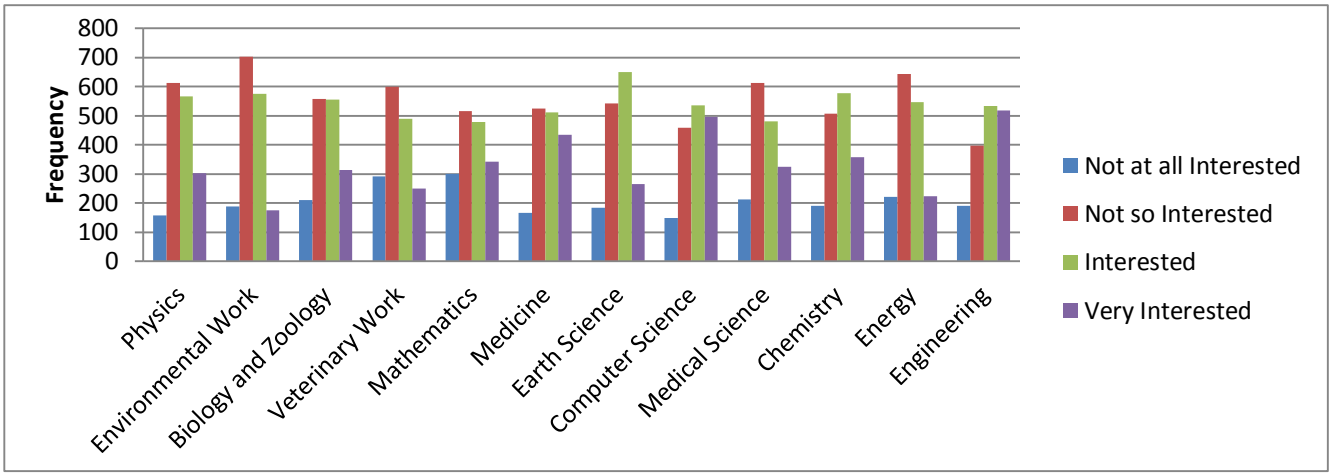

Figure 1. Students' interest in various STEM Careers, measured in the STEM pre-survey

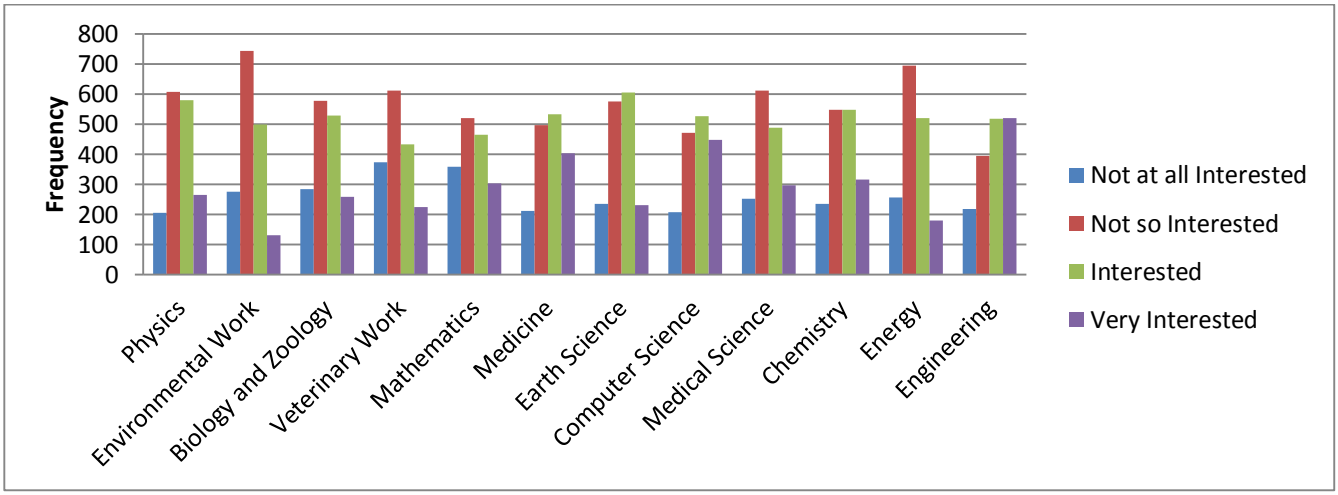

Figure 2. Students' interest in various STEM Careers, measured in the STEM post-survey

Gender Differences in STEM Careers

Changes in students' interest in each of the 12 career areas are depicted in Figure 3. Male and female students' interests in STEM careers did not change following the same pattern over time. Male students' interests increased for six of the twelve careers (Physics, Mathematics, Computer

Science, Chemistry, Energy, and Engineering). Female students' interests increased for only three (Veterinary Work, Medicine, and Medical Science).

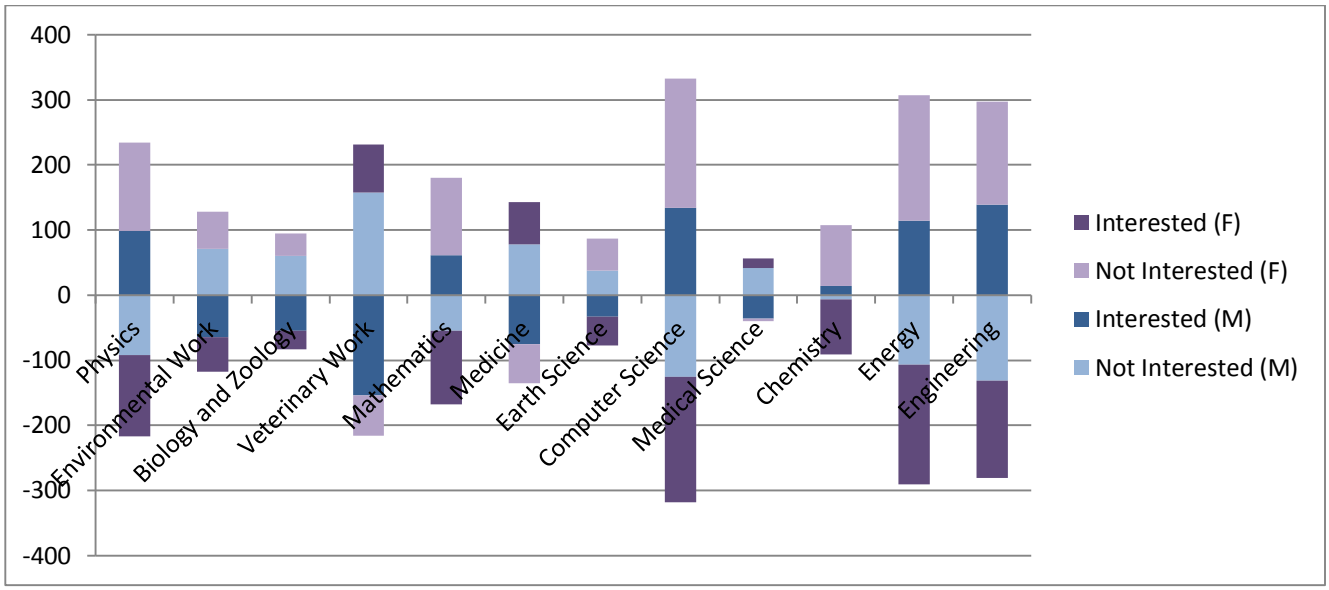

Figure 3. Change in male and female students' interest in STEM careers over time

Conclusions and Educational Implications

The findings are not surprising given the gender disparity evident in several of the career areas represented in the survey. The fact that girls are less likely to be interested in math and engineering than boys is a persistent trend. These findings have shed some light on girls' interest in STEM careers and will initiate and engage in dialogue surrounding gender disparity in STEM education. Additional research may highlight factors impacting girls' engagement with STEM initiatives. Similarly, resource development focusing on integrating STEM perspectives in education and the implications for teaching and learning is warranted. In this study, we are hopeful that outreach workshops which embrace the above mentioned measures can potentially provide female students with the support they need in order to alter or maintain their interests and attitudes towards STEM as a field of study short-term and furthermore, not "leak from the pipeline" (Blickenstaff, 2005) by fostering the confidence needed in pursuing STEM as a career long-term. Findings from this study will benefit practitioners and professional organizations through curriculum enhancement and professional development initiatives. Finally, this research has the potential to inform educators, researchers, policy makers, and curriculum developers as

to benefits, drawbacks, and challenges associated with implementing STEM initiatives, and establishing STEM partnerships between educators, community, and science and engineering professionals.

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