University Festival Promotes STEM Education

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Abstract

STEM education is argued as an essential ingredient in preparing our children for careers of the future. This study describes a university festival that includes the promotion of STEM-related career interests in young people among its goals. A total of 203 participants between the age of 7 and 17 completed both pre-event and post-event surveys. In addition, 86 participants submitted self-reflections on what they enjoyed and learned from this experience. Results suggest the event increased participants' interest in STEM-related careers. In addition, the event provided opportunities for participants to have personal dialogues with college students whom they regarded as role models, and helped them make the connection between subjects taught in school and careers they knew before, as well as new career paths.

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The United States is facing an educational crisis and losing its leading status on the international stage. The rankings of American youth in science, engineering, and math have dropped significantly since the 1970s (National Science Board, 2003; Organisation for Economic Co-operation and Development, 2006). Reflective of the decline, American youth no longer believe the United States leads the way in invention (The Lemelson-MIT Invention Index, 2011). Consequently, STEM education has been argued as an essential ingredient in preparing our children for careers of the future. Colleges and universities across the United States with a vested interest in STEM education are playing a role in generating interest in STEM disciplines. This study describes a university festival that includes the promotion of STEM-related career interests in young people as one of its goals. The study begins with a brief review of the career development literature followed by a description of the Imagine RIT Festival and data collected at the event.

Theoretical Framework

Career aspirations begin during childhood (Ginzberg, 1972; Gottfredson, 1981; Mello, 2008; Trice & McClellan, 1994) and follow a long-term process (Magnuson & Starr, 2000). Parsons (1909) trait-factor approach set the foundation for career development models and is still relevant today (Krumboltz, 1994). He argued that career choice is a three-part decision-making process: (1) assessment of one's interests and abilities, (2) gathering information related to various occupational requirements, and (3) reasoning about the self-assessment and occupational analysis. Bandura and colleagues (2001) suggest that it is never too early to begin raising awareness about career options. They note that "choices made during formative periods of development shape the course of lives" (p. 187) and this is a time when some career options become realizable.

Recognizing the value of early exposure, educators have developed multiple avenues to introduce young people to science, technology, engineering, and math. Providing adolescents the opportunity to learn through experience and reflect on those experiences inside and outside the classroom has long been seen as a way to increase awareness in STEM (American Association for the Advancement of Science, 1989; National Research Council, 1996). Underscoring the importance of early encouragement, Tai, Liu, Maltese, and Fan (2006) found experiences before eighth grade strongly predict earning a baccalaureate degree in science. More specifically, project-based learning and learning science in informal environments are two approaches that have been used to successfully increase student interest in STEM related careers (e.g. Verma, Dickerson, & McKinney 2011; Fadigan & Hammrich, 2004).

With theoretical consensus that childhood is a critical time for career development (e.g. Bordin, 1990; Super, 1990), a variety of efforts are being made to promote STEM education and career options to children. Many examples have been published in the pages of this journal. For example, teachers, researchers, and practitioners have found positive results through games (Ernst & Clark, 2012), science sports videos (Kemnitzer, 2012), clubs and science fair competitions (Sahin, 2013), robotics competitions (Chung, 2014), and community partnerships (Watters & Diezmann, 2013).

Background

Imagine RIT: Innovation and Creativity Festival is a campus-wide event that showcases the innovative and creative spirit of Rochester Institute of Technology (RIT) students, faculty, and staff. RIT President Bill Destler developed the idea for the festival, and the goal to engage visitors through hundreds of interactive exhibitions and hands-on demonstrations has remained the same since its inception in 2008. The daylong festival, located on RIT's campus in Rochester, NY, has grown from 15,000 to over 30,000 visitors.

Destler sees the Imagine RIT Festival "as a call to national service," adding that, "Innovation is one of America's best competitive advantages." The festival is marketed on television, radio, newspapers, and social media across Western New York as a free event for families. Targeted outreach promoting the educational nature of the event is made to students in kindergarten through 12th grade in the six-county area. The 2011 Imagine RIT Festival showcased over 400 interactive exhibits and hands-on demonstrations by over 3,000 students and faculty. Two of the event goals pertaining to youth are: (1) To stimulate interest in STEM-related careers, and (2) to empower American youth to see themselves as innovators and creators. This study will share the results of a survey designed to measure these goals.

Methods

The estimated number of visitors to the Imagine RIT Festival in 2011 was over 30,000 people. Upon arrival to the festival, families with youth were approached by trained volunteers and invited to take a brief pre-event survey. An embroidered festival badge was offered as an incentive to return and complete a post-event survey. As young visitors left the event, they were encouraged to visit a designated festival web page to submit, in writing, what they learned at the festival. Prior research suggests that one element of an effective intervention is a message's ability to stimulate reflection among the intended audience (Papa et al., 2000). This mixed methods approach offers valuable insights into the impact of the university festival on participants' interest in STEM careers.

Participants

Data were collected from young visitors at the Imagine RIT: Innovation and Creativity Festival on May 7, 2011. A total of 451 youth from the Rochester region volunteered to answer survey questions at the event. Of those, 376 completed the pre-event survey, 278 completed the post-event survey, and 203 completed both. Out of the 203 participants in the final sample and of those whose demographic information was recorded, 58.1% were boys and 41.9% were girls; their age ranged from 7 to 17 years old ($M = 11.71$, $SD = 2.25$); and 88.3% were Caucasian, 3.9% were African American, 2.2% were Hispanic, 2.8% were Asian, and 2.8% were from other racial or ethnic backgrounds. In addition, 86 young visitors submitted their reflections about the event in writing. Among them, 46.4% were boys and 54.6% were girls and their age ranged from 5 through 16 with an average of 9.60 years old.

Data Analysis

The open-ended approach to data collection resulted in the data being analyzed using separate, but related procedures. The responses to "What do you want to be when you grow up?" and "What did you find out that you are good at that you didn't know you were good at before today?" were content analyzed and coded. Content analysis refers to "any qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings" (Patton, 2002, p. 453).

The author developed a coding system using the United States Bureau of Labor Statistics Standard Occupation Classification system. Two coders independently classified each message using the coding tree. For example, the coding book for the first open-ended question instructed coders to classify answers as "scientist" if the response included chemist, biologist, or geologist. Responses were coded as follows: 1 = scientist, 2 = technologist, 3 = engineer, 4 = mathematician, 5 = artist, 6 = inventor/innovator, 7 = other, 8 = unsure. Similar procedures were used to gauge discipline-specific interest in the second open-ended question; across the two procedures the coders agreed in 89.3% of the cases. Responses to the post-event reflective writing activity were coded using latent content and constant comparative techniques (Lincoln & Guba, 1985; Strauss & Corbin, 1990). Two coders independently reviewed the responses, after which they convened to compare their findings. Through consensus, the coders identified four themes revealed below.

Results

Participants were asked on the pre-event and post-event survey "What do you want to be when you grow up?" As shown in Table 1, 40.5% of the young participants expressed interests in STEM-related careers and it increased by almost 6% (46.4%) on the post-event survey. More specifically, there was about a 2-3% increase in the careers related to science, technology, and engineering, while the percent for art, math, and inventor remained essentially the same.

	Pre-event	Post-event
Scientist	13.4%	16.3%
Technologist	5.4%	7.4%
Engineer	17.7%	19.7%
Mathematician	0.5%	0.0%
Inventor	3.5%	3.0%
STEM (subtotal)	**40.5%**	**46.4%**
Other	35.6%	33.0%
Artist	9.9%	9.9%
Uncertain	13.9%	10.8%

Table 1. Career Aspirations Pre-event and Post-event Comparison

Aside from the general question about their career interests, participants were asked on the pre-event and post-event survey about their interest in science, math, art, and technology on a 3-point scale (1 = not at all, 2 = a little, and 3 = a lot). A study by Royeen (1985) found a modified 3-point scale to be a valid format when surveying children age 6 to 10. Engineering was omitted in the fixed survey responses because a pilot test revealed that children did not have a baseline for measuring their interest in this discipline. This was not surprising because youth are widely exposed to science and mathematics, but engineering is often absent from K-12 curricula (National Academy of Engineering & National Research Council, 2009). Art was included for two reasons. First, the university is home to a number of world-class programs in the arts and many art-related exhibits were showcased at the event. Second, there is a growing movement among educators that art education can enhance STEM education (Daugherty, 2013) and event organizers were interested in making some comparisons about young people's interests.

Results of paired t-tests suggest a statistically significant increased interest in science, $t(202) = 3.28$, $p = .001$, 95% CIs [-.166, -.041]; technology, $t(202) = 2.50$, $p = .013$, 95% CIs [-.132, -.016]; and math $t(202) = 2.88$, $p = .004$, 95% CIs [-.133, -.025]; but not statistically significant for art, $t(202) = .58$, $p = .565$, 95% CIs [-.065, .036].

Participants were asked on the post-event survey "What did you find out that you are good at that you didn't know you were good at before today?" As shown in Table 2, a total of 50.8% of the young participants reported having discovered new skills of STEM-related careers on the post-event survey: 18.2% in science, 9.4% in technology, 17.1% in engineering, and 6.1% in math.

Self-Reflections

The reflective writings submitted by young participants ranged from 5 to 219 words, with an average of 35.38 words. Four themes emerged from the analysis: (1) the festival was fun, (2) student exhibitors were perceived as role models for young participants in the community, (3) young participants made the connection between subjects taught in school and innovative careers, and (4) young participants were inspired to pursue brand new career paths they did not know before. Example responses from each theme are provided below.

The most prominent theme was that the festival was fun. A nine-year-old girl said, "The day was so much fun! Every time I turned around there was something new to learn. I learned about DNA, Nanos, Liquid Nitrogen and you can Eat A Book! I also liked drawing on the sidewalk with the library people. I learned how to be an artist there." A seven-year-old girl said, "I had fun being creative and thinking about science, metal working, solar panels and energy." An eleven year-old girl said, "There are a lot of very hands on activities and that you do a lot of amazing experiments, art work, games, and more. My favorite parts of the day were when I got to see all the artwork,

	Post-event
Science	18.2%
Technology	9.4%
Engineering	17.1%
Math	6.1%
STEM (subtotal)	**50.8%**
Other	22.7%
Art	17.7%
Uncertain	8.8%

Table 2. Skill Discovery in STEM Careers

create my own artwork, chain metal, and experiments. I loved going to Imagine RIT I had a lot of fun and made a lot of things. I can't wait till next year!"

The following two examples exemplify theme 2: student exhibitors were perceived as role models for young participants in the community. A ten year-old girl said, "I learned how to make ublik and about all the neat stuff they do there from an engineering student." A fifteen year-old girl said, "Being a nerd is cool. People in high school don't appreciate kids who do math for fun and think about projectile motion when playing softball. At Imagine RIT, everybody else thought the same way. I got into a really intelligent conversation about matrices with a math student and a conversation about cyber security with a PhD candidate. In the future, the geeks will rule."

Third, young participants made the connection between subjects taught in school and innovative careers. An eleven year-old boy wrote, "Math and science are really important to engineering." An eleven year-old girl wrote, "I learned that math is used with digital photography and 3D imagery." A nine year-old girl wrote, "How digital photography and 3D imagery use math, how to make cement and how civil engineers use cement. Cement can even float when you make a canoe out of it. Also, you can use an iPad like a canvas and paint on it."

Finally, young participants were inspired to pursue new career paths that they did not know before. An eight year-old girl wrote, "I learned that you could go to college to learn how to make video games and work with Legos too." A ten year-old girl wrote, "I learned that simple objects can be used to create incredible and unique objects, such as robots and artwork. Also, a good education can lead to a wonderful career. Overall, mechanical engineering and technology can be fun." A fifteen year-old boy wrote, "I learned about some new computer programs and advancements in software. One thing that stood out was the Imaging Department. I was really impressed with some the things they were doing. I had a great conservation with one of the men at the station about the airplane real time feedback equipment. It made me want to look more into optics for a possible career."

Discussion and Conclusion

The goal of this study was to report on a program designed to promote STEM-related career interests in young people. Survey data from 203 participants between the age of 7 and 17 and qualitative data from 86 submissions of self-reflective essays were analyzed. Findings suggest that the festival succeeded in accomplishing two of the event goals pertaining to youth. First, it stimulated interest in STEM-related careers and second, it empowered youth to see themselves as innovators and creators. Participants' interests in STEM-related careers increased from pre-event to post-event, and the differences were statistically significant in STEM careers. A total of 50.8% of young participants discovered new skills in STEM-related fields.

The analysis of reflective essays submitted by young participants suggested that the festival immersed them in fun activities and hands-on learning; the university students were perceived as role models for youth in the local community; and the event stimulated face-to-face conversations that helped participants discover new career paths and make connections between subjects taught in school and careers previously known.

The results suggest that a university festival is an effective strategy for promoting STEM-related careers. Events like this can help children assess their interests, understand the educational requirements of various professions, and begin a dialogue about STEM-related careers. Other colleges and universities might consider the value of hosting similar events.

Colleges and universities could anticipate a wide variety of benefits by hosting similar events that showcase STEM education. Free events at universities can attract large and diverse audiences. Visitors may attend to be entertained, but they also benefit by the strategic placement of educational content. Festivals on university campuses can offer the public a unique and open invitation to learn about the most cutting-edge and creative projects. And youth attending festivals see student innovators being celebrated for their ideas. These interactions have the potential to provide youth positive role models that may not exist otherwise. Ultimately, a university festival creates a fun atmosphere that helps youth overcome apprehension about communicating with faculty and students and leads to the discovery of careers youth have never considered.

Without further engagement, the impact of the event on youth's interest in STEM-related careers might be limited to a relatively short term. However, a festival provides a perfect opportunity to showcase established programs and camps designed to promote STEM education to youth in grades K through 12. At RIT, outreach groups such as Women in Engineering (WE@RIT) and Women in Computing (WIC) have been actively involved in showcasing their programs at Imagine RIT since the festival began.

Some additional lessons learned can inform the design and evaluation of similar events in the future. For example, the Imagine RIT Festival took place on a Saturday. A number of school districts informed the event organizers that they were not able to schedule field trips on weekends. More youth could benefit from such an engaging and educational experience if similar events were planned during a weekday. Consideration should be made for youth in rural areas as well as those who do not have access to transportation. Also, the cost of an event of this magnitude could be prohibitive if corporate sponsors are not available to offset the expenses. The time required to plan a festival similar to the one described in this study is significant. Nonetheless, a university festival is a unique and effective way to engage a large number of youth through intellectually stimulating activities that promote STEM related education and careers.

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The author would like to thank Dr. Hua Wang for her assistance coding and analyzing the data.