An Integrated Approach to Promoting STEM among High School Students (Evaluation)

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Dr. Zhou is an Associate Professor at the Engineering Department of Central Connecticut State University. Her research enthusiasm and expertise lie in quantitative analyses and modeling techniques, with applications in transportation planning and engineering. Recently, she has focused on issues of STEM education since planned and directed a Federal Highway Administration (FHWA) funded outreach program: National Summer Transportation Institute (NSTI).

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Ms. Sharon Okoye, Connecticut Department of Transportation

Ms. Sharon Okoye is a senior transportation engineer with over 22 years of experience ranging from transit asset management, intermodal planning and highway design projects, to managing the FHWA federal aid Safe Routes to School program. Ms. Okoye also serves as Director of the Department's TRAC program, which is a STEM-related student outreach program, and manages Connecticut's NSTI program. Sharon holds a Bachelor's degree in Civil Engineering from the University of Tennessee, Knoxville, is a member of Women in Transportation (WTS), and 2015 recipient of WTS Rosa Parks Diversity Leadership Award.

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Introduction

A well-educated STEM workforce is critical to maintain competitiveness of the U.S. in today's global economy. Workforce shortages in STEM fields and stagnated performance of high school students in STEM curriculums have led to an increasing awareness for the need of STEM outreach programs among educators, politicians, professionals, and others. Many pre-college outreach programs have been developed and implemented nationwide.[1, 2, 3, 4, 5, 6, 7, 8] This paper presents an integrated approach to this effort and discusses statistical analysis results on program assessment.

The National Summer Transportation Institute (NSTI) program is one of the Federal Highway Administration's (FHWA) educational initiatives. It is "designed to introduce secondary school students to all modes of transportation careers and encourage them to pursue transportation-related courses of study at the college and/or university level".[9] "The partnerships were required to have, at a minimum, the active participation of an FHWA Division Office, a State transportation agency (STA), and a college or university".[9]

The Central Connecticut State University (CCSU) NSTI program is developed and implemented with tremendous involvement from federal and state agencies as well as faculty at the host university. In addition, professional associations are invited to deliver presentations, talk about real-life projects, and share insightful perspectives with young program participants. Professors at CCSU, program liaisons from the FHWA Division Office and the Connecticut Department of Transportation (CTDOT), and speakers from the industry actively interact with program participants, demonstrating an integrated approach to promoting STEM educational and career opportunities among high school students.

Program Overview

The CCSU NSTI is a one-week, non-residential program for high school students (rising 9-12 grades). A wide range of transportation modes are introduced through carefully designed curriculum activities. Activities include lectures led by professors, hands-on laboratory exercises tailored to engage teenagers, presentations by transportation practitioners, enrichment activities led by CTDOT, and field trips to Connecticut landmark projects. Program details undergo refinements and improvements each year, but basic curriculum remains the same, an example being three modules consistently dedicated to three fundamental transportation modes: land, water and air.

The land module generally covers a bridge design competition, which is a miniature version of the renowned National Bridge and Structure Competition initiated by the American Association of State Highway and Transportation Officials' (AASHTO) Transportation and Civil Engineering Program (TRAC).[10] A guest high school teacher is sent by AASHTO to CCSU to lead this session. Students first learn some basic engineering concepts, and then test their bridge design skills using ModelSmart3D software. Later, students build truss bridges of their choice in small groups (4 to 5 students in each team), using Balsa wood and wood glue. Each bridge is then loaded gradually until collapse. The team whose bridge has the highest strength-to-weight ratio wins the competition. As

shown later in the program assessment section, such hands-on activities with a competitive nature are well received by participating high school students.

Water transportation, an important element of inter-state and international commerce for the U.S., is introduced using both basic theories and case studies. A laboratory exercise acquaints students with the techniques used to maintain river transportation and the constraints engineers must address when considering the function of river transportation. Students are divided into small groups and construct a lock and dam model, using modeling clay, plastic tubs, and PVC trim board. This exercise helps students to observe how a lock and dam system can aid ship navigation both upstream and downstream.

In the air transportation module, students first learn some basic principles in fixed wing aircraft design, and then make their own aircraft models using foam boards and glue guns. Students are encouraged to work individually in this exercise to achieve the maximum level of hands-on experience, but small teams are allowed. At the end of this session, students test the efficiency of their designs through a competition. The aircraft that flies the longest distance is chosen as the winning design, regardless of weight and size. Students are also exposed to basic concepts of helicopter design and operation, and use X-plane software to simulate helicopter flight. A prototype helicopter simulator, developed and built by a professor and students at CCSU, is available to program participants who are interested in operating a helicopter in a laboratory environment.

Each educational module is enriched by hands-on laboratory exercises. Depending on schedule, the CCSU NSTI program may include concrete and steel material labs, a spot speed study, an engineering surveying, public speaking/presentation, and entrepreneurship. In addition, field trips, SAT preparation, and team building exercises are vital components of this program. A sample program schedule is given in Table 1.

Table 1. Sample CCSU NSTI Program Schedule

Time	Monday	Tuesday	Wednesday	Thursday		Friday
8:00 -- 8:30	Welcome & Survey	SAT Preparation	SAT Preparation	Bridge Design & Competition		Modern Bridge Design Techniques
8:30 -- 9:00						
9:00 -- 9:30	Admissions & Career Services	Aircraft Operations	Public Speaking & Presentation			
9:30 -- 10:00						Helicopter Simulation
10:00 -- 10:30	Campus & Engineering Lab Tour	Aircraft Design & Competition				
10:30 -- 11:00			Traffic Simulation & Operation			
11:00 -- 11:30	Professional Association Presentations					
11:30 -- Noon						Lunch @ CTDOT
Noon -- 12:30	Orientation Lunch @ CCSU	Lunch	Lunch @ CCSU	Lunch @ CCSU		
12:30 -- 1:00						
1:00 -- 1:30		Airport & State Pier Field Trip	River Systems in the U.S.	Steel Material Lab	Concrete Material Lab	CTDOT Visit & Graduation Ceremony
1:30 -- 2:00	Career Opportunities in Transportation					
2:00 -- 2:30			Lock and Dam System			
2:30 -- 3:00	Transportation Safety					
3:00 -- 3:30				Concrete Material Lab	Steel Material Lab	
3:30 -- 4:00	Team Building Exercise					
4:00 -- 4:30						
4:30 -- 5:00						

Note: The two material laboratory exercises run parallel with students split into two groups.

Program Highlights

Unique features of the CCSU NSTI program are the welcome luncheon and graduation ceremony. The welcome luncheon is scheduled on the first day. FHWA Division Office representative(s), CTDOT liaisons, university administrators (Admissions and Dean's Office), participating faculty, and speakers from the industry are invited to attend. Students are intermingled with these established professionals who have a vested interest in younger generation's education and career aspirations, empowering program participants in their pursuit of a better future. Students officially "graduate" from this program at a graduation ceremony. On the last day, students visit the CTDOT headquarters, and the visit ends with a graduation ceremony, where CTDOT Commissioner (or Deputy Commissioner), FHWA Division Administrator, and CTDOT liaisons speak to the students and invited parents, relatives, and friends. This celebration highlights achievements of the young program participants, and has been well-received by the students and their guests.

The CCSU NSTI program is well supported by government agencies, the host university, and local professional associations. Different entities play special and meaningful roles, presenting an integrated approach to stimulating high school students' interests in STEM. More specifically, participating faculty at CCSU offer their technical expertise in a spectrum of subject matters; designing their sessions with the targeted audience in mind. The FHWA Division Office provides timely guidance on implementation of the program, in addition to financial support. CTDOT liaisons provide guidance on program design, recommend activities and speakers, and assist with the coordination of field trips, the bridge design competition session, the visit to CTDOT headquarters, and graduation ceremony.

The last critical contributors are local professional associations. Many such societies, especially minority oriented ones, have outreach missions. The Women's Transportation Seminar (WTS) is a valuable partner to the CCSU NSTI program. A small group of passionate women talk about their career paths, their exciting projects, and available educational resources each year; some also participate in the welcome luncheon and graduation ceremony. The National Society of Black Engineers (NSBE) also provides guest speakers. The presence of these professionals exposes students to successful role models in STEM fields, excites the historically under-represented groups, and may leave long-lasting impacts on minority students' pursuit of education and careers in rewarding, but relatively challenging STEM fields.

Program Participants

The CCSU NSTI program focuses on promoting STEM educational and career opportunities to younger generations, with recruitment focusing on attracting historically under-represented groups. Different strategies are utilized to ensure success in recruiting a group of high school students with diverse demographic backgrounds, such as seeking assistance from other educational programs that have similar missions.

In 2014 and 2015, 41 high school students participated in the CCSU NSTI program. Among them, 32% (13 out of 41) are female; nationwide, women made up only 26% of STEM workers in 2011.[11] Sixty-six percent of the students (27 out of 41) report themselves as not being Caucasian, with 37% (15 out of 41) as African American and 7.3% (3 out of 41) as Hispanic. According to the 2011 American Community Survey, African Americans and Hispanics held about 6% and 7% of STEM jobs, respectively.[11] In addition, program participants tend to come from low-income households. For example, 24.4% of students (10 out of 41) report their annual household income as less than $30,000. Statewide, 18.0% of the households earned less than $25,000 per year and 25.7% earned less than $35,000 per year, according to the 2011-2015 American Community Survey 5-Year estimates.

A remarkably high percent of program participants' parents graduated from college: 61.0% of the mothers graduated from college, as compared to a national average of 32.7% for females age 25 and over who have at least bachelor's degrees, and 58.5% of the fathers graduated from college, as compared to a national average of 32.3%.[12] Even though parents' high level of educational attainment does not necessarily result in high household income as shown above, parents' educational backgrounds is a noteworthy factor for high school students' STEM outreach program participation.

In addition to basic demographic data collected during the student recruitment stage, a survey conducted at the beginning of this program asks a few questions on participants' academic and family backgrounds. Six students were removed from the following analysis because they did not fully complete either the opening survey or the end-of-program survey, reducing the sample size from 41 to 35.

When asked how participants heard about the CCSU NSTI program, the majority (43% or 15 out of 35) state that they learned of the opportunity from "school". This is consistent with student recruitment efforts; the outreach is directed to principals and/or counselors at local high schools. Noticeably, many participants (34% or 12 out of 35) hear about this program from "family or friends", indicating the importance of family/friend support when inviting youth to enter STEM educational opportunities. Similar results are found on why participants are interested in this program: more than half of the students attend the CCSU NSTI program because of encouragement from their parents.

Occupational information on program participants' parents and relatives (e.g., siblings, grandparents, uncles, aunts) further demonstrates that family/relatives play a critical role in promoting STEM among young people. For the 35 participants who completed the opening and end-of-program surveys, mothers of 17.1%, fathers of 42.9%, and relatives of 48.6% work in a STEM-related job, as shown in Table 2. These numbers are significantly higher than the 6% of total civilian workforce aged 25 to 64 reported by the U.S. Census Bureau.[11] Apparently, when high school students are exposed to STEM in their early years because a parent or relative works in a STEM-related field, they are generally more interested in STEM and more aware of opportunities in STEM.

Table 2: Background of Participants' Family Members

Background of Participants' Family Members	Percentage
Mother graduated from college	61.0%
Father graduated from college	58.5%
Mother works in a STEM field	17.1%
Father works in a STEM field	42.9%
Relatives work in a STEM field	48.6%

While a relatively large number of students (40% or 14 out of 35) never attended a similar program that promotes STEM, the majority (60%) did get exposure to STEM from previous educational activities. These program participants have a genuine interest in STEM and a high potential to pursue a college education in STEM fields. Program assessment based on responses from these students are of great value to designing a challenging yet interesting STEM curriculum that attracts young talent to STEM.

Program Assessments

Opening and end-of-program surveys are conducted to assess the CCSU NSTI program and to seek input to make continuous improvements. Minor changes were made to the questions related to specific program activities each year, but most questions remain the same. This section discusses program assessment results. As explained in the previous section, sample size was reduced to 35 because six students did not fully complete either the opening survey or the end-of-program survey.

Overall, the CCSU NSTI program is well received and deemed helpful by participants. Fifty-one percent of the students (18 out of 35) rate their overall experience as "highly satisfied", 46% (16 out of 35) respond they are "satisfied", none are "partially satisfied", and 3.0 % (1 out of 35) choose "not satisfied". A closer look at the written comments reveals that this unsatisfied student focused primarily on the program specific topics when answering this question; student wrote "I do think there were some aspects to this program that I did take away from but honestly, I wasn't completely drawn towards taking transportation engineering as a major in the future." Another program assessment indicator is when asked whether they would recommend the CCSU NSTI program to friends and/or relatives, 77% of students (27 out of 35) choose "yes", 23% (8 out of 35) choose "maybe", and none choose "no".

When asked whether they agree the CCSU NSTI program improved their knowledge of STEM, 66% of the students (23 out of 35) respond they "strongly agree", 31% (11 out of 35) say they "agree", one student (3%) choose "partially agree", and none choose "not agree". The single unsatisfied student in the overall experience partially agreed that this program improved the student's knowledge of STEM, indicating positive impacts of the CCSU NSTI program on high school students, even when they have already decided to stay away from a STEM field.

One NSTI program goal, set by FHWA, is to encourage participants to "pursue transportation-related courses of study at the college and/or university level".[9] Responses to one question designed to assess this outcome are shown in Figure 1. About 80% of the students (28 out of 35) "strongly agree" or "agree" the CCSU NSTI program made them more likely to choose a STEM major in college.

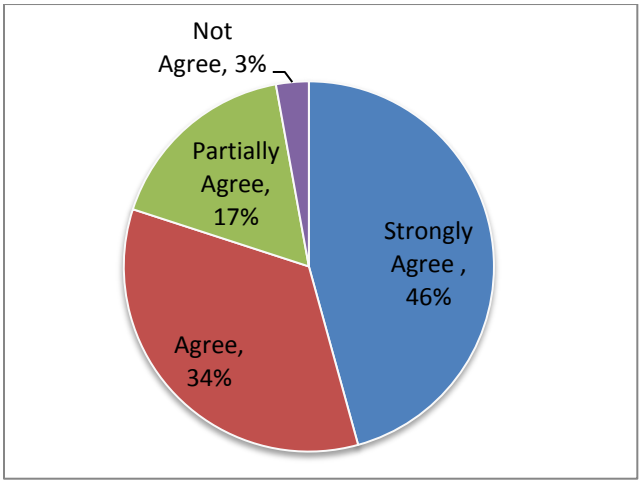

Figure 1: Response Distributions on Whether Participants Agree the CCSU NSTI Program Made Them More Likely to Pursue College Education in STEM

This important assessment criteria merits further examinations. First, the sample was divided into two groups: female vs. male. As shown in Figure 2, while a big portion of female students "strongly agree" that this program made them more likely to pursue college education in STEM, their responses are not as positive as their male counterparts. Our female participants have genuine interests in STEM, unlike many other young girls who did not apply for this program at all. But female students do not cultivate high benefits, as compared to male students.

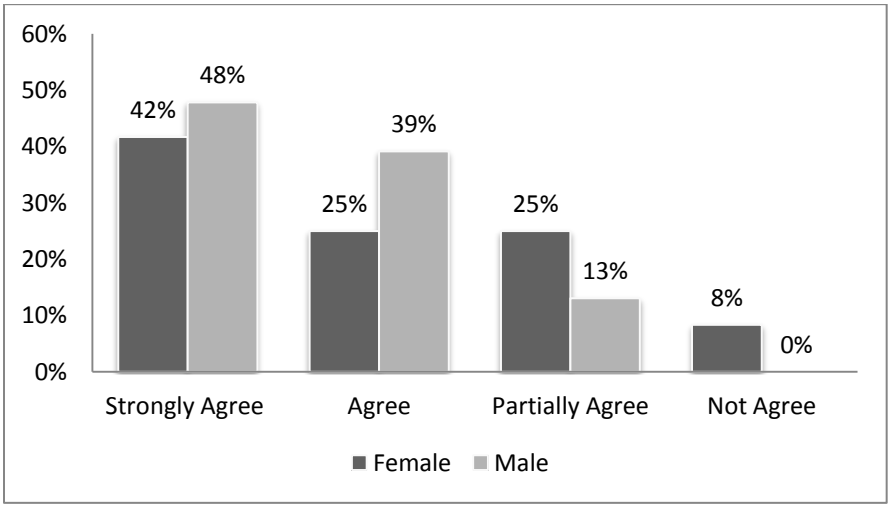

Figure 2: Response Distributions on Whether Participants Agree the CCSU NSTI Program Made Them More Likely to Pursue College Education in STEM, By Gender

For the same assessment question, the sample was then divided into two groups based on their responses to whether they agree this program *improved their knowledge of STEM*. The available four options are "strongly agree", "agree", "partially agree", and "not agree", and the distributions are 66%, 31%, 3%, and 0%, as discussed previously. Students who chose the middle two options are combined into a new group, named "Students with Moderate STEM Knowledge Improvement", while students who chose the first option are labeled as "Students with Significant STEM Knowledge Improvement".

These two groups show noticeable differences in their assessment of this program's impact on their STEM education pursuit, as shown in Figure 3. It is clear that students who believe their STEM knowledge is significantly improved after the program are more likely to pursue a college education in STEM as the result of program participation. In other words, these students seem to benefit from such outreach programs the most, and may be more confident in their readiness for relatively challenging STEM higher education that eventually leads to a rewarding STEM career. As a result, it is imperative that such outreach programs are designed with engaging activities that help participants better understand basic principles and exciting applications.

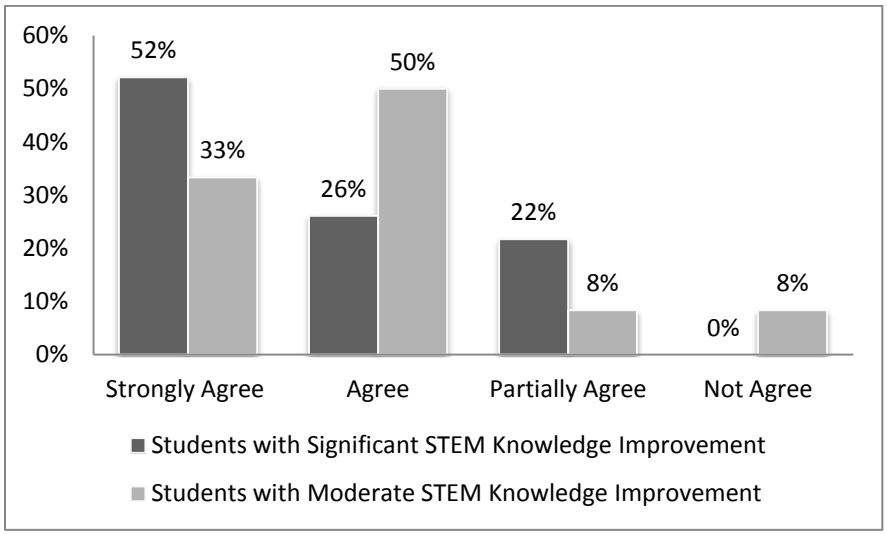

Figure 3: Response Distributions on Whether Participants Agree the CCSU NSTI Program Made Them More Likely to Pursue College Education in STEM, By Perceived STEM Knowledge Improvements

Similar to the above assessment criterion, how STEM-focused outreach programs affect participants' career choices is also of interest to educators and program decision-makers. Responses from the CCSU NSTI program participants are very positive. Forty-three percent of the students (15 out of 35) "strongly agree" that this program made them more likely to choose a profession in STEM, 34% (12 out of 35) "agree", 20% (7 out of 35) "partially agree", and 3% (1 out of 35) do "not agree" with the statement.

Educational Instruments

As discussed in the previous section, perceived improvement in STEM knowledge plays an important role in how much participants benefit from such outreach programs. Therefore, a challenging, yet attractive STEM curriculum is critical to the overall success of an outreach program. Application of proper educational instruments that are appealing to future STEM students is paramount. Findings from the CCSU NSTI program can help educators and outreach program directors develop curriculum activities that match with high school students' preferences and learning styles, and thus stimulate greater interest in STEM.

Five educational instruments are considered in this study, including software demonstration/learning, simulator operation, material testing, building exercise and competition, and field trips. Upon program closure, participants are asked whether each educational instrument helped them better understand STEM, using a scale of 1 being "not agree", 2 being "partially agree", 3 being "agree", and 4 being "strongly agree".

The building exercise and competition instrument receives the highest score of 3.76, indicating high school students learn more effectively through hands-on activities after understanding relevant principles and theories. The educational instrument with the second highest score is field trips with 3.53. It seems high school students enjoy interactions with practitioners who are supposed to be good at explaining STEM concepts from a practical point of view. Following field trips, software demonstration has a score of 3.51. This is expected because nowadays high school students are keen to computer and software applications.

The two educational instruments with the lowest scores are simulator operation (3.09) and material testing (3.17). It looks counter-intuitive because these two instruments also involve hands-on activities. However, the building exercise and competition requires a relatively good understanding of the theories/principles before participants can actually build anything. In contrast, the simulator operation does not require a thorough understanding of the simulator; the material testing instrument has similar issues. This passive learning is apparently not what high school students would prefer when they are exposed to STEM.

Written Comments

Upon closure of the CCSU NSTI program, participants are asked to provide written comments on any aspects of the program. In general, responses are highly positive and echo the evaluation results presented in the previous two sections. First, the integrated approach, with contributions from government agencies, a university, and professional associations, works well for a STEM outreach program. Students enjoy interactions with both professors in classroom and speakers from the industry. A couple of selected written comments are "The backgrounds of the professors and guest speakers were very impressive", and "I liked how the speakers made interesting conversation with the students in the program. The personal advice they provided was very helpful in developing my ideas for future choices for college and profession".

Second, high school students learn new concepts efficiently using hands-on laboratory exercises with a competitive nature, as demonstrated by the following comments: "The labs building the lock and dam system and building a balsa wood bridge were extremely helpful in understanding and being able to apply the concepts we learned during presentations", and "I really enjoyed all of the hands-on experiences like with the lab and the competitions. It was fun working with others and/or doing our best to win, as well to use quick-thinking for when there was pressure with time".

Third, the CCSU NSTI program achieves its goal of broadening high school students' horizons in STEM educational and career opportunities. A couple of students state that "I really enjoyed this experience because I don't know what to do in the future, and this program helped open my mind to other areas", and "I think it was a great program. I have been to many similar programs like at ___ University and by far this camp has been much better. I definitely loved that it was so hands on."

Participants also give a few constructive suggestions to improve this program. The most commonly cited are to have more hands-on activities, and to make the program longer so students will have "more time to learn the concepts and go into deeper detail". Other suggestions are related to program scheduling; sometimes speakers go over their allocated time, resulting in reduced time on hands-on laboratory exercises which are generally budgeted big blocks of time and therefore are the natural "sources" to recover lost time.

Conclusions

The CCSU NSTI program recruits a group of high school students with diverse demographic and academic backgrounds, and focuses on raising participants' awareness in STEM educational and career opportunities. This program offers introductory lectures and hands-on laboratory experiments with college professors, presentations by and interactions with professionals in the industry, field trips to Connecticut landmark projects, SAT preparation, team building exercises and other enrichment activities. More importantly, the CCSU NSTI program takes an integrated approach, in which government agencies, the host university, and local professional associations all play special and meaningful roles. This integrated approach makes students more convinced that a STEM college education is feasible and rewarding, by providing students with diverse perspectives.

Program assessment is very positive, and the CCSU NSTI program achieves its goal of increasing pursuit of college education in STEM. About 80% of the students "strongly agree" or "agree" that this program made them more likely to choose a STEM major in college. However, different groups gain somewhat different benefits from the program. For example, female participants do not benefit as much as their male counterparts, and students who have gained significant STEM knowledge improvement are more confident in their readiness for STEM college education.

These findings have important implications. First, it is imperative to design STEM outreach programs with engaging activities that help increase participants' knowledge of STEM, because

such programs boost students' confidence in their readiness for relatively challenging STEM higher education that leads to a STEM career. In addition, the CCSU NSTI program receives significant contributions from female professionals, exposing students to successful female role models. This practice is supposed to have positive impacts on female students' pursuit of STEM,[13] but more work is needed to cultivate female high school students' interest and persistence in STEM. The following are respective activities that, in concert with each other, could increase the benefits to female students:

a. State agencies can utilize TRAC program in middle schools to target students prior to entering high school for interest in STEM careers.
b. Program can be formed through college or universities' collaboration with STEM outreach programs that target girls, such as WTS's Transportation U program, funded by a grant.
c. Colleges and universities can develop scholarships tailored to "females" in STEM fields.
d. Colleges and universities can have female ambassador programs with representatives in various STEM fields. Ambassadors can visit high schools and/or have girls visit colleges and universities for special events (i.e., on International Women's Day or during Women's History Month).

Reaching students at an early age is key in the attempt to encourage them to pursue STEM fields. Efforts can start by targeting middle school students, with an integrated approach, drawing support from various entities, to increase student confidence and interests in STEM. More specifically, with programs like the CCSU NSTI, a curriculum with more hands-on activities and small group competitions can suit young people's learning styles and preferences, stimulating greater interests in STEM fields and careers.

Acknowledgement:

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References:

1. Nadelson, L. S. & Callahan J. (2011) A Comparison of Two Engineering Outreach Programs for Adolescents, *Journal of STEM Education*, Vol. 12, No. 1 & 2, 43-54.
2. Crittenden, K. B. & Turner, G. E. (2011) Building Relationships by Avoiding the "Show-and-Go": a STEM Project for High Schools, *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*.
3. Christie, B. A. (2012) Creating Partnerships between your University and Community-Based Out-of-School Time Programs to Improve the STEM Pipeline, *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*.
4. Goonatilake, R. & Bachnak, R. A. (2012) Promoting Engineering Education Among High School and Middle School Students, *Journal of STEM Education*, Vol. 13, No. 1, 15-21.

5. Klein-Gardner, S. S. (2014) STEM Summer Institute Increases Student and Parent Understanding of Engineering, *Proceedings of the 2014 American Society for Engineering Education Annual Conference & Exposition*.
6. Constan, Z. & Spicer, J. J. (2015) Maximizing Future Potential in Physics and STEM: Evaluating a Summer Program through a Partnership between Science Outreach and Education Research, *Journal of Higher Education Outreach and Engagement*, Vol. 19, No. 2, 117-138.
7. Huang, S., Degen, C. M., Ellingsen, M. D., Bedillion, M. D., & Muci-Kuchler, K. H. (2015) Investigating the Impact of an Outreach Activity on High School Students' Attitude towards STEM Disciplines, *Proceedings of the 2015 American Society for Engineering Education Annual Conference & Exposition*.
8. Kuhl, M. E., Kaemmerlen, J., Marshall, M., Mozrall, J. R. & Carville, J. L. (2015) Relevant Education in Math and Science (REMS): K-12 STEM Outreach Program using Industrial Engineering Applications, *Proceedings of the 2015 American Society for Engineering Education Annual Conference & Exposition*.
9. FHWA 2016, National Summer Transportation Institute Program, http://www.fhwa.dot.gov/civilrights/programs/nsti_careers.cfm.
10. AASHTO 2016, TRAC and RIDES, http://trac.transportation.org/Pages/default.aspx.
11. Landivar, L. C. (2013) American Community Survey Reports: Disparities in STEM Employment by Sex, Race, and Hispanic Origin.
12. Ryan, C. L. & Bauman, K. (2016) Educational Attainment in the United States: 2015.
13. Hill, C., Corbett, C., & St. Rose, A. (2010) Why So Few? Women in Science, Technology, Engineering, and Mathematics (published by American Association of University Women).