

# **A NOVEL APPROACH TO INTRODUCING STEM DISCIPLINES TO HIGH SCHOOL STUDENTS: THE STEM DISCOVERY PROGRAM**

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**Abstract:** This paper discusses various factors which prevent high school students from pursuing careers related to science, technology, engineering and math (STEM). A novel approach has been suggested to overcome some of these barriers which will effectively encourage students into these fields. This approach, which is based on introduction of some of the STEM professions and disciplines to students while in high school, will help them to make good, timely and informed decisions about pursuing education and careers in STEM fields. An implementation of the approach presented in this paper has been done at Wentworth Institute of Technology, Boston for the past three years.

**Key words:** STEM education high school students

**Introduction:** The shortage of people who would like to pursue careers in engineering and technology continues to be a national issue. It is projected that there will be shortfall of the people needed to fill positions in science, technology and engineering and math (STEM) related disciplines for the next several years. Unless some significant steps are taken to address this issue, this shortage will continue to grow to undesirable levels.

Students coming out of high schools have major decisions to make in terms of choice of careers, and many postpone that decision to while at college or later. A large number of students begin college with a choice of major as “Undecided”, and hope that few years of college education will place them in a better position to be able a make an informed decision. Also many students are concerned that the mathematics content of most careers related to STEM disciplines is overwhelming, and therefore would much rather pursue other careers which may be related to liberal arts, management, finance etc.

This issue was analyzed and various factors were considered which possibly lead to this. Some of these factors were identified to be :

- (a) **Career related aspects.** Students do not know much about careers in the STEM fields, regarding
1. what the job entails,
  2. compensation,
  3. types of positions,

4. whether there will be enough jobs in those fields in the future
  5. are jobs in those fields difficult to do
  6. where are those jobs located
- (b) **Education related aspects.** Students do not know how to plan their education to be able to get into these fields, including
1. which are the schools which offer these programs
  2. what does it cost to do education for these fields
  3. what courses should be done at high school to be well prepared for pursuing college education leading to these fields
  4. what is the profile of a student who can be successful in college education in these fields
- (c) **Curriculum related aspects.** Many STEM related disciplines have a very structured curriculum, in which one course feeds into another. Effectively many programs require four years from the time they begin, Students who do not begin their college education initially into these programs will end up needing a college education of five or more years to acquire a BS degree in these fields. This is especially true for engineering and technology programs. Due to this factor, it becomes a deterrent for many and they do not like to consider to transfer into an engineering or technology program from a liberal arts major.
- (d) **Background related aspects.** Many families do not have an adult who had a successful career in a STEM related field, and are not in a position to be able to encourage the students to seek out those fields. This may be due to the fact that both the father and mother are employed in non-STEM related fields, or for a variety of reasons had an unpleasant experience while working in those fields and are themselves not able to encourage the children in the family towards pursuing careers in those fields. Also many families live in communities where there is less awareness about careers in STEM fields.
- (e) **Perception related aspects.** Many students have perceptions about STEM disciplines, especially engineering and technology which discourage them from pursuing these fields. Some of these are as follows:
1. They are extremely difficult
  2. Engineering means air-conditioning and heating
  3. You have to be a “nerd” to pursue these fields
  4. They would like to pursue careers which can enable them to help others, but they do not see any way how careers in these disciplines can help others
  5. You have to be extremely good at math to succeed in these fields
  6. These fields use very difficult math all the time
  7. These careers are for men, and not for women

Taking into account all the above factors, it was planned to create a program for high school students which would address some of these issues which prevented students from pursuing STEM fields. It was identified that a critical component to the success of this would be to have students learn in detail about these professions and disciplines, and hopefully making well informed decisions early, before they begin college rather than after they have spent a few years in college with an “undecided” major.

The students availability was a major factor in determining the duration, and timing of this program. The content of the program would be such that a high school student who had completed one year of high school would be able to benefit from this program.

Based on these requirements, the STEM Discovery program was first created and offered in 2007, and then offered again in 2008, and 2009. The following are salient features about this program:

1. Introduced several types of engineering and technology to students who do not have any previous exposure to these fields. Assisted students in discovering individual interest or aptitude for one or more of these disciplines, and provided guidance to them regarding their future pursuits of these subjects. Specifically, the students were introduced to disciplines of Mechanical Engineering, Electrical Engineering, Civil Engineering, Biomedical Engineering, Bioinformatics, Computer Science and Nanotechnology.
2. This program was not for college credit, it was informational, inspirational and very hands-on.
3. It was planned to inspire interest in the STEM-subjects, and encourage the pursuit of higher education.
4. The program offered the students some insight into the professional opportunities available through the pursuit of these subjects.
5. The students were mostly rising juniors and rising seniors at high schools
6. The program was for three weeks in duration, so as to have enough time for the student to become familiar about the fields of STEM being taught, and yet not become overwhelming or boring.
7. While the period of study was limited to three weeks, through an intensive schedule of lecture and laboratory study, the students obtained an extensive sampling of the subject matter in each of these disciplines, encompassing some of the breadth of learning that a college student would obtain while at college for three weeks.

8. The program was a full day program during Summer vacation
9. Concurrent with the learning regarding these five disciplines, the program provided students with regular occasions to learn about the opportunities available to those who pursued the science, technology, and engineering fields.

It is hoped that this type of an informational, inspirational and hands-on program will have a significant impact on the student populations we intend to target. It is expected that such an initiative will:

- Inspire interest in the subjects of science, technology, engineering and mathematics (STEM) in under-represented populations within the enrollments of these subjects and majors at both the secondary and higher educational levels.
- Introduce the different types of engineering and technology to students who do not have any previous exposure to these fields.
- Assist students in discovering individual interest or aptitude for one or more of these specific focuses, and support their future pursuits of them.
- Service the youth of the nation by providing unique opportunities for academic awareness, at a time when it will not conflict with their academic schedule at school
- Generate the interest in pursuing post-Secondary education in economic and geographic areas that have traditionally low numbers of individuals with advanced degrees.
- Provide an educational, informative enrichment opportunity to high school students which will help them to determine the type of college or academic program they will want to pursue during the next few years.

The students who attended these programs absolutely loved it and felt it was a great learning experience for them. The parents of these students were also very impressed with what the students had learnt during the program, and how it had helped the students to get interested in STEM fields. Unfortunately due to logistical reasons, the program was non residential, and therefore only students who could commute were able to attend this program. Many students felt it would be much more beneficial if these programs provide an option to be residential.

The publicity for this program was achieved by contacting high school guidance counselors and principals at the schools in the area. The guidance counselors were very impressed with the concept of this program and informed their students about this program. Even though there was a modest fee for this program, and by attending this

program the students were deprived of their summer jobs and vacation for those three weeks, almost all the students who attended felt it was well worth it. At the end of the program, most students left with a STEM discipline in mind which they would take into consideration while making their college plans.

**Conclusion.** In conclusion, a novel approach to introducing STEM disciplines to high school students has been introduced in this paper. This approach requires reaching out to students via the guidance counselors, math and science teachers. The program is offered when students are out of school during their Summer vacation. In this program the students learn about several STEM disciplines by taking few classes in those fields, and doing labs to reinforce the learning. This model has been tried out at Wentworth Institute of Technology, and it was observed that the program grew in enrolment, and popularity during the second and third year. Such programs conducted throughout the nation would significantly help our students in getting inspired and encouraged to pursue STEM related careers and education at college level. It gave students the confidence and the message that some STEM disciplines are good for them, and most importantly that they can be successful in them.