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# Pre-university Outreach: Encouraging Students to Consider Engineering Careers*

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To address the need for increased enrolment in the Faculty of Engineering and Applied Science, Ryerson University, Toronto, Canada, has expanded its *Discover Engineering* programme. Initially a summer day camp targeting female high school students, *Discover Engineering* now includes an outreach programme that brings the hands-on activities directly to the classroom, and presents to co-ed classrooms, not just to female students. The authors' studies have shown that outreach programmes are essential tools for increasing awareness about the engineering profession at the pre-university level. This paper describes the outreach activities that have been effective in educating students about the challenges and rewards of engineering careers, and discusses the impact that Ryerson's *Discover Engineering* programmes have had in motivating students to consider engineering educational and career paths.

## INTRODUCTION

Across North America, companies are scrambling to find qualified professionals in the high-growth sectors of engineering and computer science, and the demand for graduates from these programmes far exceeds the supply [1]. However, this increase in demand has not been reflected in enrolment in engineering programmes. United Nations Educational, Scientific and Cultural Organization (UNESCO) statistics from the early to mid-1990s show a negligible growth in enrolment for North America, as compared to other geographical regions [2]. Figure 1 illustrates the growth in undergraduate engineering enrolments for the early to mid-1990s.

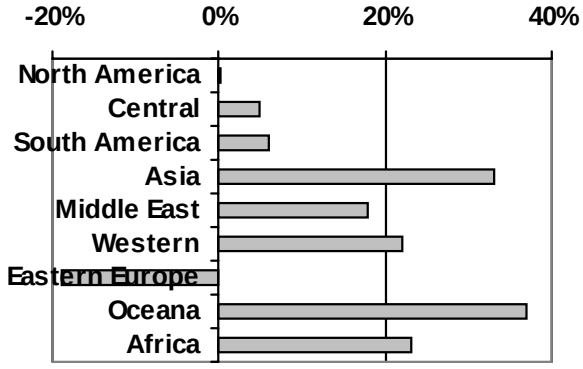


Figure 1: Growth in undergraduate engineering enrolments for the early to mid-1990s.

Although there has been a continuing climb in numbers within Canada, growth rates for engineering enrolment declined twice during the 1990s. However, the growth rate of women enrolling in engineering has consistently exceeded the growth in total enrolment in every year since the early 1980s and has not experienced negative growth [3]. Figure 2 shows the growth in Canadian undergraduate engineering enrolments.

In addition to negligible growth rates for overall engineering enrolments, there has also been a drop in the number of students enrolled in several engineering programmes, as shown in Figure 3.

Electrical and mechanical engineering are the largest programmes, with almost 10,000 students enrolled in each, and showing an increase of over 15% between 1996/1997 and 2000/2001. The third highest enrolment was in computer engineering, with just over 7,000 students and almost doubling in enrolment since

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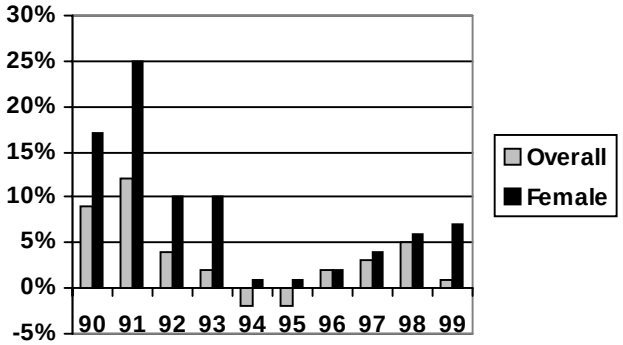


Figure 2: Growth in Canadian undergraduate engineering enrolments (overall vs female students).

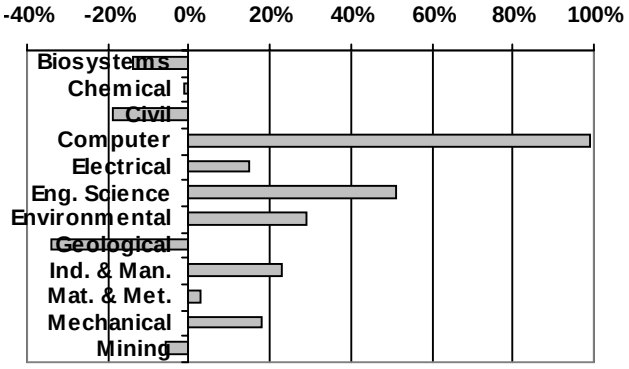


Figure 3: Percentage change in Canadian undergraduate engineering enrolments from 1996/1997 to 2000/2001 (by programme).

the mid-1990s. There were also significant increases in engineering science, environmental, and industrial/manufacturing engineering. Chemical and materials/metallurgical engineering showed fairly stable five-year enrolment, while biosystems, civil, geological and mining engineering showed a decline [4]. This is shown in Figure 4.

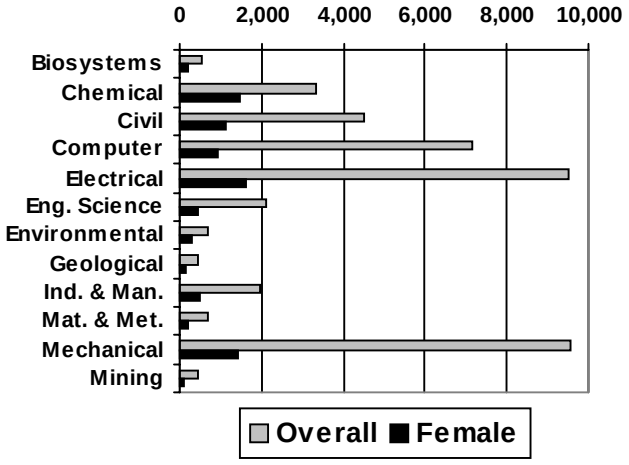


Figure 4: Canadian undergraduate engineering enrolments for 2000/2001 (overall vs female students, by programme).

While women comprised a high proportion of the 2000/2001 total enrolment in biosystems, chemical, environmental and geological engineering (39-44%), overall enrolment was small (less than 300 female students) in all programmes other than chemical engineering (with over 1,400 female students). Also, although the numbers of women enrolled in computer, electrical and mechanical engineering are high (900-1,600 female students), the overall proportions are low (13-16%) (see Figure 5) [4].

## BACKGROUND – *DISCOVER ENGINEERING*

The *Women In Engineering* (WIE) Committee at Ryerson University, Toronto, Canada, was established in 1989 with an explicit goal to increase the number of women in Ryerson engineering programmes. Its first initiative, the *Discover Engineering* Summer Camp, was launched in 1991 and several other initiatives followed.

The main objective of *Discover Engineering* is to provide education to students, especially young women, about engineering and to show them that it can be a viable career choice. This objective is achieved through involvement in hands-on activities, exposure to undergraduate engineering students, instruction by female science and engineering faculty and staff, and panel discussions with female professional engineers.

The main outcome is to increase awareness about the many facets of engineering and hopefully to convince some of the students to pursue engineering as a career.

### Success of *Discover Engineering*

Exit surveys have been conducted among camp participants since 1991 [5]. To measure a long-term success of the camp experience and to track the

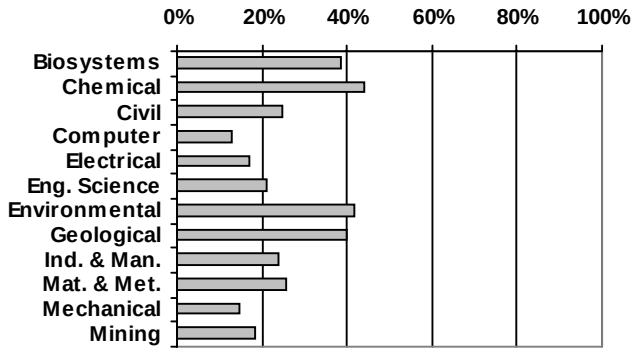


Figure 5: Canadian undergraduate engineering enrolments for 2000/2001 (percent women, by programme).

number of participants who go on to choose engineering as their field of study, follow-up phone surveys were conducted in 1993, 1996 and 1999. On average, 80% of the interviewed camp alumni went on to study at a university. There, over half enrolled in engineering programmes, and of those, almost three-quarters said that the summer camp experience greatly or moderately influenced their decision [6]. This is shown in Figure 6.

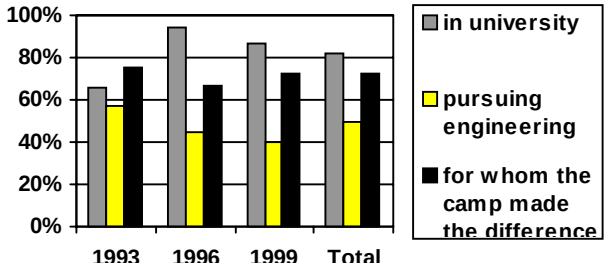


Figure 6: Success of the *Discover Engineering* Summer Camp.

### *Discover Engineering* Summer Camp

The primary objective of the summer camp programme is to introduce young women in high school to the challenges and rewards of engineering through a variety of fun, hands-on activities and discussions led by women engineers, scientists and students.

Female students who have completed grade 10 comprise the target audience; however, girls who have completed grades 9 through 13 are also welcome. Although the students have usually already chosen to continue with the mathematics/science stream in high school, they have not necessarily decided on a career path. The overall goal of the programme is to increase awareness among these students about careers in non-traditional areas of applied science at a time when a decision about post-secondary education is at the forefront of their minds.

The summer camp is a weeklong day camp based on hands-on activities in a stimulating learning environment, which allow the young women to achieve success by working on comprehensive engineering projects in a variety of engineering fields. Camp counsellors, who are female undergraduate engineering students, guide the participants throughout the week as they attend various sessions taught by female professors, staff and alumni.

### *Discover Engineering* High School Workshops

The high school workshop programme was initiated in September 1999 as an extension to the summer camp. The goal of the new initiative is to raise awareness about careers in engineering among all high school students. This means that the programme is offered in a co-ed classroom environment and not just to female students. However, the use of female presenters (faculty, staff and engineering students) provides strong positive role models for the young women. As well, this helps change stereotypical perceptions of engineers, held by both male and female students in the audience.

### *Discover Engineering* Career Conference

In May 2000, The WIE Committee hosted the first annual *Discover Engineering* Career Conference for young women in high school. This initiative was designed for female high school students, their parents, teachers and guidance counsellors to explore careers in engineering.

The career conference is designed for young women currently in/entering grades 11, 12 and 13. During the day, the participants take a close look at careers in engineering and meet with successful women from the profession. The programme begins with a panel discussion session where women working in various engineering-related careers share some of their stories. This is then followed by a number of workshops from which the participants choose two workshops of their choice.

## THE IMPACT OF *DISCOVER ENGINEERING* PROGRAMMES

Questionnaires and evaluations have been used to survey students about their knowledge of engineering before and after participating, and assess the impact of these programmes on their interest in pursuing engineering as a career option.

Almost all of the summer camp (DESC) and career conference (DECC) participants indicated that the camp increased their knowledge about engineering, as well as their interest in considering engineering as a career option. When brought directly to the classroom, over three-quarters of the workshop (DEHS) participants indicated that the programme increased their knowledge about engineering and almost half indicated that the programme influenced them to investigate engineering as a career option (see Figure 7).

## ANALYSIS OF *DISCOVER ENGINEERING* HIGH SCHOOL WORKSHOP PROGRAMME

Survey participants at the High School Workshops 2000/2001 included 1,200 students representing almost 20 different High Schools in the Toronto area. The gender ratio was 48% male to 52% female students.

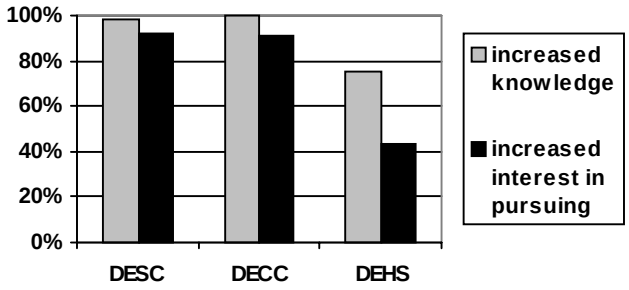


Figure 7: Impact of *Discover Engineering* on knowledge of engineering and interest in pursing engineering as a career (2001 programmes).

## Knowledge of Engineering Prior to Workshop Programme

Career options in engineering are not well known to most adults, let alone teenagers, and are not well represented in high school curricula or through career guidance counselling [7].

Prior to the workshop presentation, students completed a pre-programme questionnaire, which included asking them to describe what an engineer does. Students were allowed to indicate *not sure*. The descriptions were reviewed and scored as *not sure*, *incorrect description*, or *correct description*.

Less than one-third of the high school workshop participants were able to correctly describe engineering or what an engineer does, and senior students were only slightly more knowledgeable than junior students.

Almost half of the students were *not sure* what an engineer does and almost 20% of the students wrote an incorrect description. Male students were more confident in answering; with 43% indicating *not sure*, 22% writing an incorrect description, and 36% correctly describing engineering. Female students were less confident in answering; with over half (54%) indicating *not sure*, 17% writing an incorrect description, and 29% correctly describing engineering (see Figure 8).

When reviewed by grade, senior students were only slightly more knowledgeable than junior students.

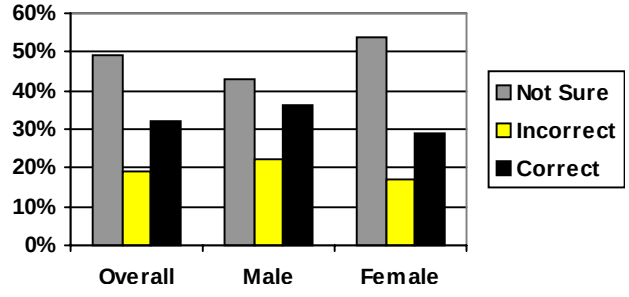


Figure 8: Knowledge of engineering, prior to *Discover Engineering* High School Workshop (by gender).

Roughly 20% provided incorrect answers regardless of grade (see Figure 9).

The most common incorrect description given was that an engineer *fixes things*. This description was deemed too vague. Other examples of incorrect descriptions include:

- *I think an engineer is a person who works with engines.*
- *I think they fix things like cars.*

The most common correct description given was that *engineers design and build things*. Other examples of correct descriptions include:

- *An engineer designs things and puts them together to make them work.*
- *An engineer comes up with innovative ideas and solves problems.*

## Interest in Pursuing Engineering as a Career

Prior to the workshop presentation, students were asked if they were interested in becoming an engineer. For the general population, almost half of the male students were interested, yet less than 20% of the female students were interested in becoming engineers. This is shown in Figure 10.

When students who had knowledge about engineering (those who correctly described engineering) were

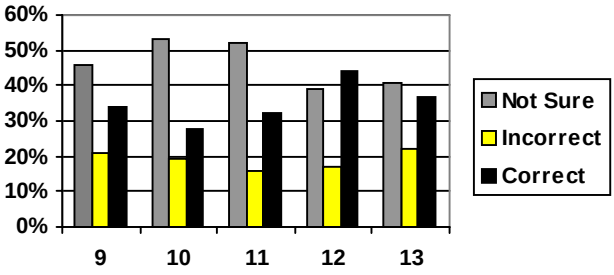


Figure 9: Knowledge of engineering, prior to *Discover Engineering* High School Workshop (by grade).

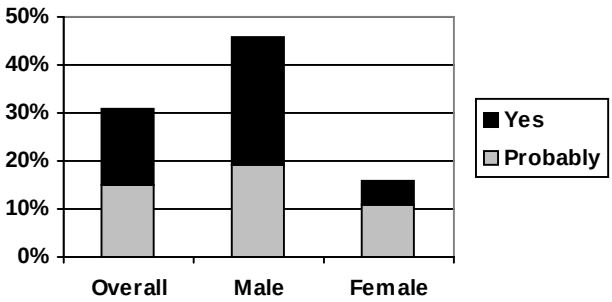


Figure 10: Interest in pursuing engineering as a career, prior to *Discover Engineering* High School Workshop (all participants).

reviewed separately, the interest level was only slightly higher (see Figure 11).

When reviewed by grade, senior students were slightly more interested than junior students (see Figure 12).

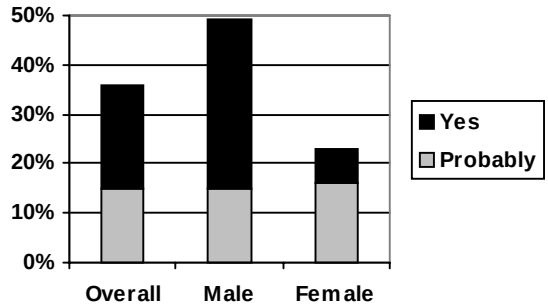


Figure 11: Interest in pursuing engineering as a career, prior to *Discover Engineering* High School Workshop (correct answers only).

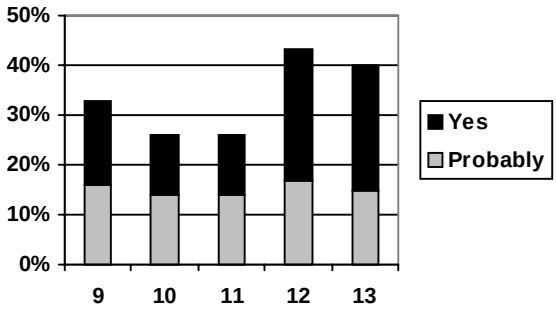


Figure 12: Interest in pursuing engineering as a career, prior to *Discover Engineering* High School Workshop (by grade).

## *Discover Engineering* High School Workshop Activities

The *Discover Engineering* High School Workshop programme is presented by Ryerson University faculty, staff and students. The goal of the workshop programme is to encourage young people, especially women, to pursue a career in science, technology or engineering. The *Discover Engineering* High School Workshop programme develops a communication bridge between the women presently involved in science, technology and engineering and prospective students in secondary schools.

Workshop presenters are female university students who are studying to pursue a career in engineering, as well as Ryerson faculty and staff members. Presenters are individuals who are able to communicate well with various age groups and volunteer their time to visit classrooms to inform students about future career opportunities and try to eliminate stereotypes of gender roles.

Each workshop begins with a 15-20 minute discussion about what engineering is, how it applies to our daily lives and about opportunities in engineering. After the discussion, a hands-on activity takes place, based on one of the modules listed below, followed by a question and answer and workshop evaluation period. The duration of the workshops can be tailored to the school's schedule, but typically run for 70 minutes.

Module 1 looks at engineering challenges. Topics covered include: problem-solving, teamwork, communications skills, civil engineering and human factors engineering. Students are organised into teams (approximately four students) to tackle an engineering challenge. The purpose of this module is to expose students to the *human-side* of engineering and different ways of communicating. Students will also learn the importance of teamwork, communication and cooperation in problem-solving situations. Team members will be assigned different *job profiles*, which describe a limitation such as *technician A may only use their left hand, technician B is not able to speak, technician C may only use the scissors*. *Job profiles* must be incorporated into solving the engineering challenge of building the highest straw and marshmallow tower with a limited number of materials, which must comply with the specifications provided. Variables are based on whether a team member fails to comply with their job profile, failure to meet a deadline and the height of the finished product.

Module 2 involves engineering design. Topics covered include: problem-solving, engineering design process, project development, budgeting, design, teamwork and project testing. Working in smaller groups (approximately three students), teams are required to budget, draft a design and build a structure that will contain an egg and protect it from cracking/breaking once dropped from the top of a ladder onto the floor. The purpose of this module is to expose students to the engineering design process; identify the problem, define their objective, determine their criteria and constraints, brainstorm possible solutions, budget for their chosen project design and implement their idea. Each team is given $30 in *Discover Engineering dollars* to purchase the items they require for their design at the *Discover Engineering convenience store*. The most cost-effective design, which successfully protects the egg from breaking, wins.

## Knowledge and Interest in Pursuing Engineering as a Career Post-workshop

After participating in the workshops, the students completed a post-programme evaluation. Three-quarters of the students indicated that the programme increased

their knowledge about engineering and over 40% indicated that the programme increased their interest in pursuing engineering as a career.

For male students, over 70% indicated that the programme increased their knowledge about engineering and over 50% indicated that the programme increased their interest in pursuing engineering as a career.

For female students, almost 80% indicated that the programme increased their knowledge about engineering and almost 40% indicated that the programme increased their interest in pursuing engineering as a career (see Figure 13).

In order to assess the impact of the workshop programme on future engineering enrolments, interest in pursuing engineering before and after the workshops was directly compared (see Figure 14).

This study shows an overall 50% increase in interest in pursuing engineering careers after participating in the workshop programme. With 1,200 students participating in the 2000/2001 programme, there were more than 500 students considering pursuing engineering with 150 of them becoming interested due to participating in the workshop programme.

When reviewed by gender, there was a small increase in interest by male students, whereas the interest level more than doubled from less than 20% to almost 40% for female students. Based on the number of students participating in the 2000/2001 programme, there were an additional 15 male and 135 female students interested in pursuing engineering due to participation in the workshop programme.

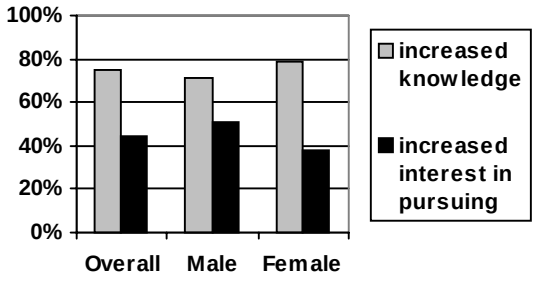


Figure 13: Impact of *Discover Engineering* High School Workshop programme on knowledge of engineering and interest in pursing engineering as a career (by gender).

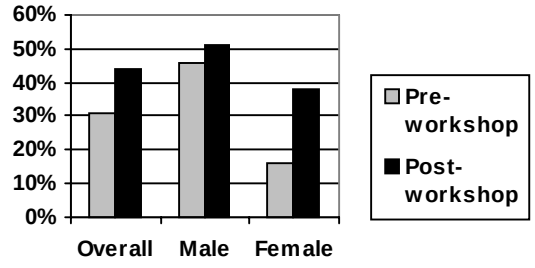


Figure 14: Comparison of interest in pursuing engineering as a career, before and after *Discover Engineering* Workshop programme (by gender).

## CONCLUSIONS

Outreach programmes are essential tools for increasing awareness about the engineering profession at the pre-university level. Studies have shown that the existing level of knowledge about engineering is minimal, even in the senior grades, and that participation in outreach programmes, such as Discover Engineering, significantly increases interest in pursuing engineering as a career.

While it is still too early to tell the actual increases in engineering enrolment due to the expansion of the *Discover Engineering* programme, the numbers indicate a positive contribution that Women In Engineering at Ryerson is making towards its stated goal of recruiting women into engineering, and increasing overall engineering enrolments.

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## BIOGRAPHIES

Lisa Anderson is the Coordinator for the Women In Engineering (WIE) Office at Ryerson University, Toronto, Canada. In her current role as WIE Coordinator, Lisa works as a support person for Ryerson's women engineering students, providing counselling and referrals and coordinating mentorship and professional development opportunities for students. Her other focus is the *Discover Engineering* programme, which includes high school outreach, in-class presentations, a career conference and a summer engineering camp for young women in high school. Lisa received her BASc Degree (Mechanical Engineering) from Queen's University in 1990.

Before joining Ryerson, Lisa worked for 10 years as a consulting engineer with MCW Consultants Ltd in Toronto, Canada. She was an Associate Partner with MCW and Manager of the Tenant Systems Department. She was responsible for overseeing the mechanical and electrical design for building services in the construction industry and was involved in all aspects of design and analysis of commercial mechanical systems including HVAC, plumbing and fire protection.

Kimberley Gilbride is a Professor in the Department of Chemistry, Biology and Chemical Engineering at Ryerson University, Toronto, Canada. She received her BSc degree from Concordia University in 1980, her MSc degree from University of Guelph in 1982, and her PhD degree in Microbiology from the University of Toronto in 1989. Dr Gilbride joined Ryerson in January 1989 and teaches in the areas of microbiology, molecular biology and biotechnology. She currently holds a grant from the Natural Sciences and Engineering Research Council of Canada to study the diversity of microbial populations in industrial and municipal wastewater. Her other research interests include the recruitment and retention of women in non-traditional careers, specifically engineering and natural sciences.

She has been involved with the Committee for Women In Engineering (WIE) since its inception in 1989 and chaired the Committee between 1998 and 2000. Her activities in this area include designing evaluation material and analysing data to assess the impact of *Discover Engineering* programmes and helping to establish the *Discover Engineering* High School Workshop programme.