How does a high school outreach program engage our future scientists?

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Abstract: *The Secondary School Enrichment Program (SSEP) is one of the outreach initiatives developed in the Faculty of Science, The University of New South Wales (UNSW). In the face of declining enrolments in the enabling sciences, the program seeks to foster a culture of academic generosity by bringing our current and future scientists together to participate in authentic scientific research. Developed jointly with a local, non-selective but high performing secondary school, the SSEP aims to draw talented students into university science degree programs, particularly in the enabling science disciplines.*

The SSEP provides secondary school students with an insight into university campus life and how research is conducted via their participation in a research project, under the mentorship of science PhD students. Since its inception three years ago, the program has obtained consistently positive feedback from the participants. However, in order to better understand the benefits of such a program, this paper investigates the program's perceived educational benefits for these students through pre- and post-program surveys. The program's effectiveness will be defined in terms of (a) students' interest in science; (b) providing an authentic scientific experience, (c) introduction to campus life, and (d) increased interest in tertiary study, tertiary study of science and study at UNSW.

Here, we share our experiences in developing and coordinating the program, and evaluating its success in achieving the above objectives. Discussion will focus on exploring the usefulness of such programs to reinvigorate interest in tertiary study in science, and the feasibility of expanding the program.

Introduction

The Faculty of Science at UNSW has developed a number of outreach programs to foster ties with the community and engage talented students. One such example is the Science Secondary School Enrichment Program (SSEP). This program was initiated by the Head of Gifted and Talented Program at Moriah College, in collaboration with the UNSW Faculty of Science's Marketing Office and the Associate Dean (Education) and utilises our graduate science students as a resource for public outreach (Giblin and Pagen 1998). The program brings our current and future scientists together with the intention of attracting talented students to study science in our faculty. It provides a unique opportunity for talented high school students to experience university campus life and to engage in science through an authentic research experience.

Traditionally, science is studied by bringing the outside world into the classroom. Tinker and Krajcik (2001) outlined how this approach often results in learning that has little or no relevance to students outside the classroom. In contrast, the SSEP provides school students with an opportunity to extend their knowledge beyond the classroom and learn through experimentation in a real-life laboratory and through scientific exploration. Based on the current literature, the SSEP was designed to model scientific practice to enhance student learning. This was achieved by utilising a variety of learning and teaching strategies i.e., inquiry based learning (Bruner 1961), experiential learning (Kolb 1984), authentic learning (Herrington and Oliver 2000), peer learning (Boud, Cohen, and Sampson 2001) and reflective practice (Kolb 1984).

Aim

The aim of this study is to investigate the academic value of the SSEP to see whether it has achieved the intended outcome of engaging 'our future scientists'. We examined the effect of the program on the future scientists (i.e. the secondary school students) in terms of their: interest in science and

scientific research; study intentions; and knowledge and confidence in scientific research. We also examined the impact of the program on our 'current researchers' (i.e. the post-graduate mentors) in terms of their self-perception of their abilities with respect to graduate attributes such as communication skills, leadership and teamwork. However, the results of this investigation will be covered in a future paper.

Method

In 2008, ten postgraduate PhD students were recruited from the Faculty of Science to act as 'research mentors' for the SSEP. Half of these mentors had previously been involved in the SSEP. The mentors were from the disciplines of Biology, Chemistry, Medical Science, Material Sciences and Engineering, Physics and Psychology. Their research topics included: steelmaking; diesel oil spills; advanced electronics; psychological examination of aesthetics; astronomy; magnetic semiconductors and the involvement of viruses in human cancers.

Twenty-five Year 9 and 10 students, enrolled in Moriah's 'Honours' Program, participated in the SSEP. These students came to the UNSW campus for five sessions: (1) a 'meet and greet' session (mentors and students met each other and completed pre-program surveys); (2) – (4) 3 half day laboratory visits (students worked in groups of 2–3 with their mentors on the experiments they had designed); and (5) the presentation evening (each group of students gave a five minute presentation on their work to the mentors, Faculty staff, Moriah College teachers, parents and fellow students).

Participants (both mentors and school students) were voluntarily recruited for this study from the SSEP. From this group, only one student indicated non-consent, thus the majority of the students' responses were included in this study. As required by the ethics guidelines, parental consent was sought for participants who were under 18 years of age (i.e. the secondary school students).

Results

Overall, the post-program surveys indicated that the secondary school students appreciated the program. Most students identified the content or subject matter of their research project as what they'd learnt. For example, one student said, 'I learnt how to measure the progression of HIV using a computer simulation programme called *Matlab'*. Only a few exceptions reflected on the research process. The main challenges identified were: (i) time constraints of the project; (ii) communicating effectively with student peers and mentors i.e. effectively presenting their research findings; and (iii) grappling with an area of science that was new to them (e.g. understanding the terminology and/or the background techniques).

What did you learn from the enrichment program?
72% (18) of the students commented that they had learned about the content or subject matter of their research discipline and five of these identified the relevance and application of this knowledge. 52% (13) of students responded that they had learned about 'research' (i.e. what goes on in a research laboratory and how a research scientist works). 20% (5) commented that they had learned a lot about university life.

Interest in science
Using a 5-point Likert scale (1 = *no interest*; 5 = *extremely interested*), students rated their interest in science. In the pre-program surveys, 88% (22) of students rated their interest in science as *interested* or *extremely interested*. Post-program, this dropped to 76% (19). While many (>50%) students indicated an interest in science related professions (e.g. medicine, engineering, IT or an astronaut), only one (4%) student mentioned 'scientist' as a career option pre-program. Post-program, terms like

scientist, sports scientist, zoologist, marine biologist and *biochemical researcher* appeared in students' responses and the number of students that aspired to careers in science or mathematics increased to 27% (6). In addition, three of the four students who did not identify a career before the program indicated science or mathematics as a possible career option after completing the program.

Confidence in science research and study intentions

On a 5-point Likert scale, students rated their pre- and post-program levels of knowledge in scientific research. A positive shift of the mean was observed in the students' ratings in the areas of: tasks of a research scientist (mean shift = 0.7), science research and development at UNSW (mean shift = 0.5) and the process of designing a scientific experiment (mean shift = 0.4). In contrast, the shift in students' confidence in undertaking a research project was variable (Figure 1). From the pre- to post-surveys, no reliable changes were observed in students' intentions to study at university, study science at university or study at UNSW (Figure 2) as only nine students completed these questions on the post program surveys.

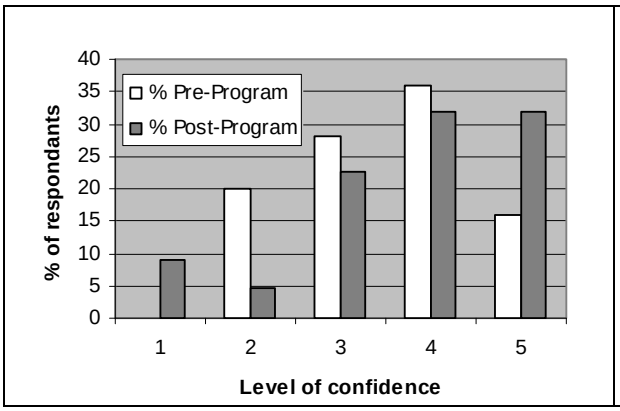

Figure 1. Pre- and post-program ratings of confidence in undertaking a research project (1=Not confident at all, 5=Very confident)

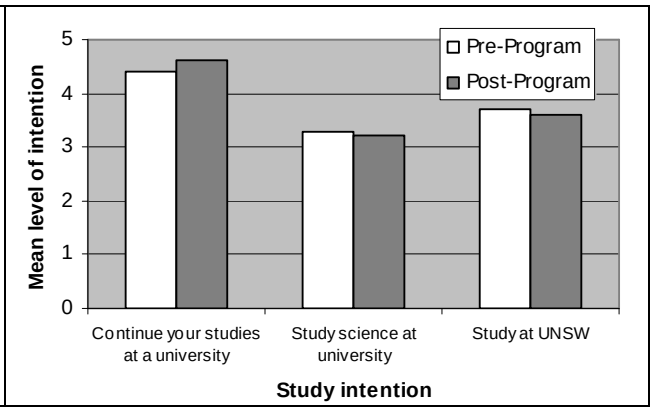

Figure 2. Pre- (Total n=25) and post-program (Total n=9) changes in study intentions (1=No way, 5=Definitely)

Discussion and conclusions

Engaging our future scientists

Since its inception in 2005, the SSEP has evolved into a science education outreach program. Increased resources have been provided to make the program more relevant to students and the experience more worthwhile for mentors. This program provided a platform to promote science to a group of talented students who are potentially our future scientists. There has been very little change in the students' average overall rating of their level of interest in science, however, these were already highly motivated students with a keen interest in science.

There was a shift in students' career aspirations to science-related careers. This is a positive indicator of the program's success in empowering the students to broaden their vision of professional applications of science. It should be noted that this increase in the appeal of science as a career option was achieved against the backdrop of a polarised level of confidence in undertaking a scientific research. Hence, the drop in level of confidence in some students is not a failure of the program in promoting science and scientific research but is helping students to discover the realities and challenges involved in carrying out authentic scientific research and clarifying their own assumptions about scientific research.

The SSEP proved to be useful in promoting a career in science as a viable option for the students who had participated in the program. The program is deliberately open and flexible which

appears to be attractive to these highly motivated students. However, is this the best approach to engage our future scientists? Where will our future scientists come from? What are some of our assumptions about our future scientists? Are these assumptions valid? These questions will be considered and discussed in a year-end review of the SSEP to ensure its relevance and effectiveness amid an increasingly competitive and rapidly changing tertiary education landscape.

Where to from here?

The anxiety in trying to grasp the theoretical underpinnings of their research project in a short period of time was expressed by many students in their survey responses and was not unexpected. To help reduce the anxiety of the students and improve the overall experiences in the program, we will work closely with the school to integrate basic knowledge and writing tools (such as that presented by Keys, Hand, Prain and Collins 1999) that will promote the students' construction of knowledge, help build their confidence and equip them with the skills to undertake a research project. Since the students in the program are in Years 9 and 10, the long term influence the program may have on their choices at university will not be evident until these students are in a position to make UAC application, which will be a future longitudinal study.

Future planned expansion of the program includes collaborating with other schools and universities, and linking with national outreach programs such as the CSIRO Student Research Scheme (SRS, http://www.csiro.au/org/pscs.html) and Science and Technology Awareness Raising (STAR) Peer Tutoring Program (http://about.murdoch.edu.au/star/navpage.html). One of the most rewarding parts of the program is the students' presentations of their experiments and findings. We are exploring recording of these presentations for a wider audience (e.g. other schools – both local and international) through media such as *YouTube*, which will also facilitate future expansion.

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