Education Research and Perspectives
An international journal

Volume 41, 2014, Pages 232-253
© The Graduate School of Education
The University of Western Australia

Storytelling Scientists: What do PhD Students Get Out of Going Back to School?

Jan. E. Dook[†]

The University of Western Australia

A common response to headlines such as: "There is a crisis in science and mathematics education" is for educational or research organisations such as universities, to offer outreach programs either based in schools or on campus. The SPICE program at The University of Western Australia is one such program. A strategy adopted by SPICE to support school students is the Travelling Scientist project. Travelling scientists are doctoral students who visit secondary students and talk about their science journey. While the overall aim of the Travelling Science project is to broaden study and career options of secondary students, this paper focuses on travelling scientists. Narrative accounts are used to describe their experiences and through these gain some insight into professional and personal benefits and drawbacks. A framework of graduate attributes as a measure of professional value shows clear benefits from being a travelling scientist, but these benefits must be weighed against time management issues.

Introduction

It is well documented that numbers of secondary students enrolling in science, technology, engineering and mathematics-related (STEM) subjects continue to decline (eg Tytler, Osborne, Williams, Tytler & Cripps-Clarke, 2008), resulting in reduced numbers studying them, and preparing for a STEM career. In an attempt to halt or even reverse this flow, universities (eg Moskal & Skokan, 2011; Guedens & Reynders, 2012; McClure, 2012) and research centres (eg Barnett & Johansson, 2006) offer outreach programs that seek to connect schools, and hence teachers and students, with their particular university and/or centre. Primary reasons for initiatives vary, as do

[†] Address for correspondence: Associate Professor Jan Dook, The Centre for Learning Technology, The University of Western Australia (M016), 35 Stirling Highway, Crawley WA 6009. Email: Jan.Dook@uwa.edu.au .

strategies. However most science-targeted programs include a focus on increasing student engagement with STEM as well as opening minds to the possibility of university study. The University of Western Australia (UWA) offers a science outreach program: SPICE.

SPICE (not an acronym) is a partnership between UWA and the Western Australian Department of Education (DoE), that supports science education through providing enrichment opportunities to science teachers, as the role of teachers is central to student engagement (Tytler et al., 2008) and achievment (Hattie, 2003). Indeed, as stated in a government report from the UK, “All the evidence from different education systems around the world shows that the most important factor in determining how well children do is the quality of teachers and teaching” (Department for Education, 2010, p. 9). SPICE is staffed by a director, coordinator, curriculum consultants (ex-teachers), writers, computer programmers, graphic artists and small administration team.

SPICE has been operating since 2006 and is considered to offer strong support to science teachers. Hackling and Bowra (2011) evaluated the program and in their recommendations to DoE stated, “There is no doubt that the PD, resources and professional learning support provided by SPICE is of a high quality and they are well targeted to meet teachers’ needs and students’ interests” (p. 40). SPICE aims to “spice up” science teaching and does so through three pillars of support: development of teaching and learning resources that target the Australian Curriculum and showcase UWA research; in-school professional development using SPICE resources; and on-campus professional learning opportunities such as lectures, workshops and laboratories.

Although the SPICE program focuses on teachers, SPICE offers some student activities. An initative under the SPICE umbrella is the Travelling Scientist project that aims to broaden study and career options of rural secondary students. It was conceived and started by SPICE in 2009 as a response to inequities experienced by regional schools regarding access to a range of learning experiences (Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006). Travelling scientists, who are PhD students from different science disciplines within UWA, accompany SPICE curriculum consultants when they visit regional schools. The curriculum consultant and SPICE administration liaise with schools regarding all aspects of the visit. While in school the travelling scientist presents to students in class groups, and covers all year groups.

Travelling Scientist presentations are visual narratives that tell a personal story. The PhD students speak about their school experiences: how they made their subject choices; what subjects they studied; what barriers they faced. They also talk about university life and how it differs from school life. They mention their research project but presentations are focused on how or why they are doing a PhD, what a PhD is, as well as future plans. In essence, they talk about their personal science journey.

It is worth noting that schools visited by travelling scientists are in regional Western Australia, and a number of these schools have high Aboriginal enrolments and often young, inexperienced teachers on staff (personal correspondence, Pilbara and Kimberley school principals). As Western Australia has a coastline of 12,889 km (Landgate, n.d.) this is not trivial. Distances travelled in these regions are vast and trips often require being away for two to three days. For example, Broome, which is a town in the Kimberley region of Western Australia, is situated 2,250 km from Perth.

Each year PhD students are identified and recruited into the project with a range of scientific disciplines and both genders represented. Having a pool of travelling scientists is important as students move in and out of the program (as they graduate). This also ensures there is usually a travelling scientist free to participate as they have varying availability throughout the year. Criteria used to select travelling scientists include being excellent communicators, appropriate role models, and willingness to be involved. Prior to presenting talks in school, travelling scientists prepare and present a trial presentation to the SPICE team.

As coordinator of the SPICE program, and specifically the architect of the Travelling Scientist project, I am interested in gaining insight into personal experiences of travelling scientists. Although having some understanding of benefits and drawbacks will be helpful for recruitment purposes and organisational structure of the project, this study seeks to address the question if participation in the Travelling Scientist project enables development of valuable graduate attributes. This paper has been written due to my participation in a series of educational workshops held throughout 2013 with colleagues from the Faculty of Engineering, Computing and Mathematics, facilitated by colleagues from the Faculty of Education, UWA.

Framework

While school education grapples with issues regarding lack of youth engagement in science, university programs of study increasingly focus on employability and education that addresses future challenges (Haigh & Clifford, 2011). Education offered at tertiary institutions is often described by articulating skills and attributes required to graduate. Postgraduate students, in particular, are supposed to acquire generic skills. Indeed a UWA website states, "… generic or transferable skills required for success in a graduate research degree are the same skills that are in high demand by employers" (Benefits of Research, 2012). Generic attributes identified include: time management, dissemination of research, oral communication with general audiences, sensitivities to cultural issues, and awareness of big picture issues.

In this study, these graduate attributes provide a framework enabling views expressed by Travelling Scientists to be aligned to the university context.

Literature

STEM education

Although technology and scientific innovation are increasingly drivers for most fields of employment, there is a perceived crisis in STEM education: students seem to be disengaged with science. Tytler and colleagues (2008) use the analogy of a STEM pipeline that progressively loses students as they move from early education through to entry-level employment. Studies in the United States suggest that interest may be lost as early as late primary school (Moskal & Skokan, 2011); and evidence from the ROSE study

(Sjøberg & Schreiner, 2010) suggests that students from western countries have less positive views towards science than students from developing countries. In general, students do not think that the work of scientists is exciting and find it difficult to relate to science (Tytler et al., 2008). Interestingly, the majority of students decide, before the age of 14, whether to follow a STEM-related career (see discussion in Tytler et al., 2008, p. 86). Tytler and colleagues (2008) suggest that linking students with contemporary STEM practice such as "schemes that import STEM professionals into school" (Tytler et al., 2008, p. 142) or partnerships with organisations such as universities, may offer student enrichment as well as access to role models. Lyons and Quinn (2010) in their study of declining science-subject enrolments, add weight to this recommendation. They found many students could not visualise themselves as scientists and suggest that creating awareness of the variety and scope of science-based careers, through interactions with practising scientists, would be valuable.

Stereotypes of scientists were first explored by Mead and Métraux (1957) when they asked 35,000 American high school children to write an essay describing their image of a scientist. In further work, Chambers (1983) developed an analysis framework, the Draw a Scientist test (DAST) that enables researchers to analyse drawings of scientists to reveal stereotypical views. The stereotypical image of a middle-aged male wearing a lab coat and performing dangerous experiments persists. Studies since 1957 continually confirm stereotypes in the United States (Finson, 2006; Painter, Jones, Tretter & Kubasko, 2006), Australia (Schibeci, 1986), United Kingdom (Newton & Newton, 1998) and Europe (Christidou, Hatzinikita & Samaras, 2010; Ruiz-Mallén & Escalas, 2012). More recently, Milford and Tippett (2013) found that pre-service teachers' DAST drawings (N=165) predominantly reflected stereotypical scientists (bearded male, lab coat, dangerous experiments, wild hair) but results were dependent on previous experiences. Those who had a formal science background (minimum BSc) drew less stereotypical representations of scientists than those with less formal science experiences.

Children's perceptions of scientists, however, can positively change as a result of an intervention such as a scientist visiting a classroom (Huber & Burton, 1995; Painter et al., 2006). Importantly, these changes are not transitory. For example, Painter and colleagues (2006) observed that one year after an intervention, consisting of a week-long science experience in nanotechnology, students' positive views remained intact.

While stereotypical views of scientists have been investigated, research on stereotypical views or expectations held by teachers, regarding their students, is complex and beyond the scope of this paper.

It is known that student beliefs about science can influence selection of career choices and that minority-group students are underrepresented in science-based tertiary study, possibly as a result of lack of role models, as well as their perception of science-based careers (Lindner et al., 2004). Added to this is the role of family. Parents and siblings often serve as role models for occupational choices. While Lindner and colleagues' study (2004) was set in rural Texas, parallels with rural Western Australia are clear: rural students potentially hold limited views of scientists and science-based careers.

From a university point of view, outreach programs can have positive impacts on staff and students. Andrews, Weaver, Hanley, Shamatha and Melton (2005) found that university students involved in outreach programs were motivated to support these programs in order to improve their personal communication and teaching skills, as well as desiring to contribute and have fun. Such students were also keen to share knowledge, enthusiasm and appreciation for science, correct misconceptions and attract new people into science (Andrews et al., 2005). Laursen, Thiry and Liston (2012) found that immersive experiences in outreach programs influenced career paths of science and engineering students. Students gained insight into intended careers and direct involvement with colleagues.

Effects of participation on university staff are varied but certainly in the United States, the National Science Foundation recommendation that research grants contain an outreach component has resulted in staff initiating contact with outreach program coordinators (Moskal

& Skokan, 2011). In short, making science visible to the next generation is important.

Graduate attributes

University education aims to develop, in their students, attributes that are evident on completion of their degrees. These attributes, often called graduate attributes, refer to skills, knowledge and abilities beyond disciplinary knowledge (Barrie, 2012). For example, Litchfield, Frawley and Nettleton (2010) identified six, key work-ready graduate attributes following consultation with professional societies across Australia. Attributes deemed to be important were: ethics and professionalism; a global perspective; communication capacity; ability to work well in a team; ability to apply knowledge; and, creative problem solving and critical thinking skills.

Graduate attributes are supposedly an outcome of the process of higher education. There is, however, often a difference between rhetoric and the reality of learning opportunities and experiences (Barrie 2012). For example, an Australian online survey was completed in 2008 by 1064 academic staff from 16 universities across Australia, seeking responses to questions regarding graduate attributes (de la Harpe & David, 2012). The majority of surveyed staff (73%) thought that graduate attributes should be an important focus for their university and included in the curriculum but there was a consistent gap between staff beliefs and their teaching and assessment practice (de la Harpe & David, 2012). For example, while most staff believed critical thinking was important only two thirds reported putting an emphasis on it in their teaching.

UWA like other universities is explicit about the generic skills required for successful completion of a post-graduate degree. More specific skills include: effective time management; identification and dissemination of the impact and benefit of research within the scholarly discipline and broader community; being able to communicate verbally, graphically and textually with specialist and general audiences; to be knowledgeable, informed and thorough as well as being self-motivated and able to motivate others; being adaptable, innovative and sensitive to ethical, social, and cultural issues; and be aware of big picture and day to day issues (Benefits of Research, 2012).

What is not clear from the list of skills is how post-graduate students can develop these skills and attributes. The role of post-graduate supervisors is known to be important in PhD success (Sinclair, 2004; Platow, 2012), but many PhD students are not given opportunities that would enable them, for example, to communicate with a general audience, disseminate research within the broader community or develop sensitivities to cultural issues (Graduate Skills of Research Students, 2009).

The Travelling Scientist project therefore is an initiative that may provide both schools and universities with opportunities. Interaction with young research scientists offers school students insight into the work of a scientist and highlights career paths. For doctoral students, the project provides a means to potentially develop several graduate attributes.

Method

I took an interpretative approach in this study, primarily as my aim was to "make sense of, or interpret, phenomena in terms of the meaning people bring to them" (Denzin & Lincoln, 1994, p. 2). I wanted to understand personal experiences, both positive and negative, of travelling scientists.

Data were collected from six, experienced travelling scientists: three female and three male. As each had participated in at least two travelling scientist trips and collectively they had talked to more than 4700 secondary students, they were considered to be experienced and in a position to comment and discuss issues relating to the Travelling Scientist project. All six subjects were current research students enrolled in a science-focused doctoral program at UWA. Disciplines represented by students included nanotechnology, biomechanics, marine neuroecologist, astrophysics, behavioural ecologist and forensic science.

The six travelling scientists that fit the criteria of at least two trips were contacted by email and invited to participate in an individual interview. All six responded and indicated they were pleased to be asked about the project. The interviews were conducted by myself in an informal setting at UWA, (usually over a coffee) where their experiences were discussed within a framework of questions: "What is your key motivation for participating in the Travelling Scientist project?", "What do you think you have gained from being in the Travelling Scientist project?" and "Have there been any drawbacks?". These questions formed the basis of interviews however interviews were semi-structured to enable exploration of ideas. Interviews were approximately 30 minutes in length. Audio recordings were made of each interview and data transcribed (Ethical approval RA/4/1/6335).

Data were initially analysed by inductive coding of the three main questions: motivation, benefits and drawbacks. While differences were apparent regarding motivations for joining the project, common threads emerged in relation to benefits and drawbacks from participation in the project, which also related directly to the study framework: graduate attributes. Threads were pulled together into broader patterns of meaning, conceptualised thematically and reconstructed into five first-person narrative accounts (Connelly & Clandinin, 1990) that are a synthesis of perspectives. All narratives were drafted by me then refined through an iterative process with colleagues during educational workshop meetings. Each short narrative explores a key theme and is written from the point of view of a hypothetical travelling scientist. Titles for narratives were mainly derived directly from words that had been consistently used by travelling scientists during their interviews. I used narrative accounts as my research interest was in the human experience of being a travelling scientist, as well as being a form that can offer insight or reveal experiences (Black, 2011; Elliott, 2012).

Results

During the interview participants were asked to talk about their motivation for initially joining the Travelling Scientist project. Interestingly, all articulated different reasons for joining. These can be separated broadly into either "self-centred" or "altruistic" groups. Self-centred motivations included: formalise outreach participation so there could be a good reason for PhD extension if time issues (with PhD studies) became a problem; improve public speaking skills; spread word of a major science project; continue with outreach work that had been part of a previous job; and, disseminate personal research to a wider audience. Only one travelling scientist stated an altruistic reason: sharing the passion of science; and correcting own high school science situation where there had been no exposure to any scientists.

When discussion shifted to benefits and drawbacks of participation in the project there were more consistent responses and the following five themes emerged.

The first theme, confidence, was commonly found in the literature (Andrews et al., 2005; Laursen et al., 2012) and was a strong theme in all interviews.

Confidence

During my honours year, public speaking was something I struggled with. When I started my PhD one of my aims was to improve that aspect of my skill set. In my university we do a student expo once a year. It’s hard to get people to do it because they’re afraid of public speaking. Even in my research group meetings, some of my peers lack confidence when they have to talk to the group about their results.

Presenting research to colleagues is important in the academic world. All scientists need to be able to do that effectively. If you can’t explain what you’re doing to someone with no background then you don’t really understand it yourself. Developing confidence in your ability to speak to both experts and non-experts is an important part of a PhD.

Being a travelling scientist means I have travelled to country schools in Western Australia and spoken to school students from Year 8 through to Year 12. In my presentation I talk about my research and what I do as a scientist. It’s interesting that high-school students can seem scary but once you get there and you start talking they’re great. They ask questions and are interested in what you have to say. You have to translate your research into simpler terms than you would with an expert audience, but that’s good practice.

I’ve become more relaxed and natural in all my presentations and can now have a conversation with my audience. This makes me feel confident and if I can get Year 9 or 10 students to be quiet and listen to what I’m saying, talking to a roomful of academics isn’t that intimidating!

In analysing the narrative it is clear that the act of talking to secondary students about their personal journey has resulted in all travelling scientists developing greater confidence in public speaking. Importantly, this confidence seems to have transferred to the academic arena.

Transference to the professional, academic world is also evident in the second narrative: Being professional. Attending and participating in conferences is an integral part of a professional scientist's life. Being professional considers expectations now held by travelling scientists towards themselves and their colleagues.

Being professional

When I was a high school student university people came and talked at us about science pathways but I found it boring. When I started my PhD studies and started to get involved in outreach activities, I realised that people were interested in what I was doing. I began to understand that I had credibility and they thought of me as a scientist. That was a weird thing to accept as I just thought of myself as a student.

Because of my involvement in the Travelling Scientist project I've become a science communication snob. I don't like it when things are not organised or executed properly. It's important to be professional; if you're going to do it, get it right. I have been to talks where there's lots of text and statistics and after the first slide I lose interest. I start using my iPhone and have no idea what the talk is about.

I've realised that talking to students is the same as talking to scientists. No matter to whom you are talking, whether they're scientists, politicians or students, you need to captivate them and keep their attention. At a recent conference I presented my talk by pictures and videos and got fantastic feedback. Everybody was interested because it was unlike any of the other talks.

The style of presentation used in the Travelling Scientist project is visual narrative through which travelling scientists tell students their personal stories. As discussed in Being professional, travelling scientists now expect certain standards in a presentation and have developed an awareness of the importance of visuals in communicating their message. Interestingly, this visual form of presentation resulted in research students gaining insight into their specific scientific disciplines, as shown by Stories.

Stories

Doing a PhD is a challenge. It takes time and keeping motivated can be hard. It's easy to get lost in detail and forget why you are doing the work, especially if you're working by yourself. Getting a balance between doing your work and doing other things is sometimes difficult.

I was asked to become a travelling scientist. When visiting country schools I talk to students not only about my research but also about how I got to be doing a PhD. I talk about subjects I did at school, what I liked doing and how I'm navigating my way through school and university.

As well as improving my public speaking, talking to school students has actually helped my understanding of my discipline and science as a whole. Fielding questions like "What are black holes?" and "What is dark energy?" makes me think.

Taking a step back and seeing my PhD project as a whole is helpful. Talking to school students about my story has helped me define the big picture for my research. It has helped me maintain my enthusiasm for my PhD and even rekindled my passion. Telling my story also reminds me of my own journey, how far I've come and how much I've grown.

Stories are a great way of communicating with students because everyone resonates more with a life story than saying things like "This is what science is about." One student said, "You're only 24 and you've done all of that. Wow!" He understood that it was my story and I could see that he was thinking, "If she can do it, so can I." Giving talks like this is easy because all I have to do is remember my own life!

In exploring this narrative it is apparent that travelling scientists, who are research students, are able to examine their own journey and as a result develop awareness of how their current research fits into the broader picture. Developing a global perspective or big picture is considered to be a key graduate attribute. Indeed, lack of a global perspective has been identified as a key weakness of students (Litchfield et al., 2010).

The fourth theme, Stereotypes, focuses on an aspect that the Travelling Scientist project attempts to showcase: scientists are normal people who may do amazing things.

Stereotypes

Stereotypes are everywhere. I'm sure that I hold views that are stereotypical and don't represent reality. Science stereotypes are common. Think of a scientist and most of us visualise an old guy with wild hair wearing a lab coat and blowing things up in test tubes. Of course, there's not one of my fellow PhD students who fit that stereotype.

When I was at high school I had no idea about the world of science. I never met any scientists and I didn't know a single thing about research. I had no idea how broad science could be and how many opportunities there are. If you've never been exposed how would you know?

Some teachers have stereotypical images of their students. When I visit regional schools as a travelling scientist some teachers say, "Oh they're not interested.", or "They won't listen to a word". But I found just the opposite: enthusiastic, questioning students.

By being a travelling scientist I'm breaking down a stereotype, possibly for both students and teachers. Before one presentation I heard the teacher say, "Now we've got a speaker and she's a female scientist," and the kids said, "She's a FEMALE scientist?" Seeing a female doing something with guns certainly breaks down the stereotype.

It's important that all travelling scientists are young students. It gives an instant connection. Hopefully school students realise their stereotype is wrong. Maybe after a Travelling Scientist presentation they might realise that you don't have to be brilliant at school and that normal people can make a career of science. Maybe they can start to see a pathway for themselves.

In examining this narrative, the travelling scientists clearly see themselves as ambassadors for science and people who can actively and positively change student's existing negative perceptions of scientists and science-based careers. It would be interesting to determine if students and teachers held similar views.

While travelling scientists were positive about their participation in the project, inevitably there are drawbacks. Predictably, one consistent issue discussed by all participants was time. Another issue that was raised is not surprising given the expectations that students now hold as presented in the narrative Being professional. The fifth theme, Barriers, highlights negative aspects experienced by travelling scientists when visiting schools.

Barriers

Being a Travelling Scientist can be time-consuming. In the first six months I did a lot of trips. It could have been stressful. It worked out as I was able to manage my time because the trips worked in well with my schedule but you can lose your work-flow.

The first trip I went on was a bit haphazard and I didn't know what to expect. At one school, they forgot I was coming. A teacher frantically ran around to get some students together and then said, "Right, just talk to them." Not an ideal situation.

Occasionally students are rowdy in the classroom, which is unsettling. I've had a student stand up and wander around the classroom. I didn't know what to do so I just let him go.

Once or twice I've gone on a trip and only spoken to small groups of students. It's a long way to go for just one or two talks. On the other hand, on one trip I spoke so much that I lost my voice. A happy medium would be good.

Sometimes I don't think students are responding well to my talk and I feel as though I'm wasting their time. Having someone completely disinterested in what you're saying is hard to deal with. If that happens I try to stay positive. There are usually a few students who are listening.

Reflecting on this narrative, travelling scientists are expressing their dissatisfaction with a lack of professionalism, as echoed in the narrative Being professional, as well as being mindful of the issue of time. Not only their time but also the time of their audience: the students. Time is also alluded to in the narrative Stories: "Doing a PhD is a challenge. It takes time and keeping motivated can be hard".

Discussion

While the focus of this paper is to gain some insight into motivations, benefits or drawbacks experienced by young PhD students who have participated in the Travelling Scientist project, there are indirect signs that STEM outcomes in schools and science stereotypes may benefit as a result of a travelling scientist visit. As established previously, there is solid evidence that secondary students are disengaged with science, cannot visualise the work of scientists and have little awareness of the scope and variety of science-based careers (Tytler et al., 2008; Lyons & Quinn, 2010).

While travelling scientists were not directly asked questions about student engagement in their interview, the tone of all interviews was positive. Indeed, engagement of students was commented on in two narratives: Stories, "They ask questions and are interested in what you have to say" and Sterotypes, "But I found just the opposite: enthusiastic, questioning students". As previous studies have found that students can hold more positive perceptions about science following interaction with scientists (Huber & Burton, 1995; Painter et al., 2006), and Lyons and Quinn (2010) advise that interactions with practising scientists would be valuable it is reasonable to suggest that travelling scientist visits are a positive experience for schools to both help dispel negative science stereotypes and promote STEM education.

Unlike the study of Andrews and colleagues (2005), motivations of participants to join the Travelling Scientist project were largely self-centred. Only one travelling scientist articulated altruistic reasons: sharing their passion for science and giving students exposure to scientists. During interviews, however, it became clear that involvement in the project resulted in benefits that were not anticipated. Participants acknowledged that while they did improve their confidence in public speaking, which was an expected outcome, they unexpectedly gained insight both into their own research and discipline as a whole. Furthermore, increased expectations regarding personal conduct translated into the professional arena as exemplified by the comment in Being professional, "At a recent conference I presented my talk by pictures and videos and got fantastic feedback. Everybody was interested because it was unlike any of the other talks". As all travelling scientists gained benefits beyond their initial motivation, this finding can be highlighted during recruitment discussions with potential travelling scientists.

To determine if there is any value, in terms of professional development, for research students to participate in the Travelling Scientist project, I used stated UWA research student attributes as a loose framework. Two UWA graduate attributes are directly linked to communicating effectively: "communicate verbally, graphically and textually with specialist and general audiences" and " identify and disseminate the impact and benefit of research within the scholarly discipline and the broader community" (Generic Skills of Research Students, 2009).

As illustrated in Stories, all travelling scientists articulated, not surprisingly, that a key outcome from their participation was developing confidence in public speaking. This was a strong theme in all interviews and speaking to school students obviously provides practical experience in communicating with general audiences and disseminating research. Importantly, this gain in confidence transferred to speaking in the research arena as exemplified by the comment in Being professional, "I have realized that talking to students is the same as talking to scientists. No matter to whom you are talking, whether they're scientists, politicians or students, you need to captivate them and keep their attention." There is no doubt that the ability to be a confident, articulate speaker is a key professional skill. Indeed, communication skills are consistently ranked by employers as being the most desirable attribute for potential employers (Macquarie University, 2005).

Another phenomenon that emerged through participation in the project was becoming aware of the big picture. Stories, illustrates how the act of talking to school students, using a narrative approach, gave research students insight into their own discipline and how their personal research fits into a bigger picture. When involved in research it is easy to immerse yourself into minutiae so being forced to consider links and connections to the discipline as a whole, and also possibly to more concrete examples, has helped these students develop the capacity to be "aware of big picture and day to day issues" (Generic Skills of Research Students, 2009). Development of a global perspective or understanding of the big picture is also highlighted as a key graduate attribute by Litchfield and colleagues (2010).

Another graduate attribute refers to being "sensitive to ethical, social, and cultural issues" (Generic Skills of Research Students, 2009). As all schools visited are rural and many have high Aboriginal student enrolment, travelling scientists have had direct exposure to different social and cultural norms. While participants did not specifically discuss ethical, social or cultural issues during their interview, there is a sense of cultural value in the narrative Stereotypes. They were clear that they were showcasing science culture and were role models for science. It was important to them that they dispelled the stereotypical attitude of both teachers and students, and promoted the message that scientists are normal people who may do amazing things.

Good role models are considered to be people who are attractive, competent and share characteristics, such as age and gender, with the observer (MacCallum & Beltman, 2002). Travelling scientists are young, attractive and competent. Role models, particularly for observers that have low belief in their own abilities, should also be seen as being similar in some way to those observers (MacCallum & Beltman, 2002). By telling their own story, including difficulties that observers may share such as dyslexia, indecision and subject failure, travelling scientists provide a realistic picture for students and therefore may be considered to be good role models.

While travelling scientists were positive about their participation in the project, drawbacks also emerged as described in the narrative, Barriers. Time management was a noticeable issue that is in part alleviated by having a group of travelling scientists rather than relying on one or two individuals. However no travelling scientist considered that they had fallen behind in their research work because they participated in the project indicating that their personal time management was sound, supporting development of another graduate attribute: time management. Nevertheless, as all participants independently discussed time in their interview, it is obviously an issue to be considered when planning school visits and recruiting travelling scientists.

Being exposed to and having to deal with unruly students also emerged as a challenge. This is a difficult issue as schools visited for the Travelling Scientist project, more often than not, have quite a high number of disengaged youth, as this is the group of students the project and the strategy employed directly targets. Part of the appeal of travelling scientists is that they are young and as stated in the narrative, Sterotypes, give an “instant connection” with school students. This issue could potentially be managed by SPICE through more careful school liaison, ensuring the school is prepared for the visit with a teacher present in an appropriate venue.

Conclusion

Clearly, participation in the Travelling Scientist project gives doctoral students direct opportunities to develop important graduate attributes in addition to providing personal satisfaction by dispelling negative attitudes to science. It is likely that participation will result in different benefits than expected. Barriers to participation mainly relate to time management and organisational issues in the school.

There is scope to explore more aspects of the Travelling Scientist project. Being a travelling scientist improves personal communication skills and enhances several graduate attributes, but, does the project broaden study and career options for school students? Do stereotypical views about science and scientists change as a result of a travelling scientist visit? What do teachers think about a travelling scientist visiting their school? These questions provide rich opportunities for further research.

Acknowledgements

I am grateful to Winthrop Professor Helen Wildy, Dr Elaine Chapman and colleagues in the Engineering, Computing and Mathematics Education Research group for their advice and support.

References

Andrews, E., Weaver, A., Hanley, D., Shamatha, J.H. and Melton, G. (2005). Scientists and Public Outreach: Participation, Motivation and Impediments. *Journal of Geoscience Education, 53*(3), 281-293.

Barnett, R.M. and Johansson, K.E. (2006). The education and outreach project of ATLAS – a new participant in physics education. *Physics Education, 41*(5), 432-436.

Barrie, S.C. (2012). A research-based approach to generic graduate attributes policy. *Higher Education Research and Development, 31*(1), 79-92.

Benefits of Research. (2012). Retrieved from http://www.studyat.uwa.edu.au/courses-and-careers/postgraduate/research/preparation/benefits.

Black, A. (2011). The language of arts in narrative inquiry: A methodology of representational shapes. *Studies in Learning, Evaluation Innovation and Development*, *8*(2), 67-82.

Chambers, D.W. (1983). Stereotypic images of the scientist: the Draw-a-Scientist Test. *Science Education, 67*, 255-265.

Christidou, V., Hatzinikita, V. and Samaras, G. (2010). The image of scientific researchers and their activity in Greek adolescents' drawings. *Public Understanding of Science, 21*(5), 626-647.

Connelly, F.M. and Clandinin, D.J. (1990). Stories of experience and narrative inquiry. *Educational Researcher*, *19*(5), 2-14.

de la Harpe, B. and David, C. (2012). Major influences on the teaching and assessment of graduate attributes. *Higher Education Research and Development, 31*(4), 493-510.

Denzin, N.K. and Lincoln, Y.S. (1994). *Handbook of qualitative research.* Thousand Oaks, CA; Sage.

Department for Education. (2010). The Importance of teaching: The Schools White Paper, 2010. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/175429/CM-7980.pdf.

Elliott, J. (2012). Gathering Narrative Data. In Sara Delamont (Ed) *Handbook of Qualitative Research in Education*. Cheltenham: Edward Elgar.

Finson, K. D. (2003). Applicability of the DAST-C to the images of scientists drawn by students of different racial groups. *Journal of Elementary Science Education*, *15,* 15–26.

Generic Skills of Research Students. (2009). Retrieved from http://www.postgraduate.uwa.edu.au/supervisors/supervisors/generic-skills.

Guedens, W.J. and Reynders, M. (2012). Science outreach programs as a powerful tool for science promotion: an example from Flanders. *Journal of Chemical Education, 89,* 602-604.

Haigh, M. and Clifford, V.A. (2011). Integral vision: a multi-perspective approach to the recognition of graduate attributes. *Higher Education Research and Development, 30*(5), 573-584.

Hackling, M.W. and Bowra, B. (2011). SPICE research and evaluation study. Unpublished report, The University of Western Australia.

Hattie, J. (2003). Teachers make a difference. What is the research evidence? Australian Council for Educational Research, October 2003. Retrieved from http://www.decd.sa.gov.au/limestonecoast/files/pages/new%20page/PLC/teachers_make_a_difference.pdf

Huber, R.A. and Burton, G.M. (1995). What do students think scientists look like? *School Science and Mathematics, 95*(7), 371-376.

Landgate (n.d.) Interesting facts about Western Australia. Retrieved from http://www.landgate.wa.gov.au/corporate.nsf/web/interesting+Facts+About+Western+Australia.

Laursen, S.L., Thiry, H. and Liston, C. (2012). The impact of a university-based school science outreach program on graduate student participant's career paths and professional socialization. *Journal of Higher Education Outreach and Engagement*, *16*(2), 47-78.

Lindner, J.R., Wingenbach, G.W., Harlin, J., Li, Y., Lee, I-H., Jackson, R., Johnson, L., Klemm, W., Hunter, J., Kracht, J. and Kochevar, D. (2004). Students' beliefs about science and sources of influence affecting science career choices. *NACTA Journal*, June, 2-7.

Litchfield, A., Frawley, J. & Nettleton, S. (2010). Contextualising and integrating into the curriculum the learning and teaching of work-ready professional graduate attributes. *Higher Education Research & Development*, *29*(5), 519-534.

Lyons, T. and Quinn, F. (2010). *Choosing Science. Understanding the declines in senior high school science enrolments.* Retrieved from http://simerr.une.edu.au/pages/projects/131choosingscience.pdf.

Lyons, T., Cooksey, R., Panizzon, D., Parnell, A. and Pegg, J. (2006). *Science, ICT and Mathematics Education in Rural and Regional Australia. The SiMERR National Survey.* Retrieved from http://simerr.une.edu.au/pages/projects/1nationalsurvey/Abridged%20report/Abridged_Full.pdf.

MacCallum, J. and Beltman, S. (2002). *Role models for young people. What makes an effective role model program.* A report to the National Youth Affairs Research team. Retrieved from http://academia.edu/604330/Role_Models_for_Young_Peopl e_What_makes_an_effective_role_model_program_A_report_to_the_National_Youth_Affairs_Research_Scheme.

Macquarie University (2005). *Macquarie University Science, Engineering and Technology Study:* Insight into the attitudes and opinions of NSW secondary students, current tertiary students and science professionals towards SET study and careers.

McClure, M. (2012). Stanford Report, July 31 2012. Retrieved from http://news.stanford.edu/news/2012/july/science-education-program-073112.html

Mead, M. and Métraux, R. (1957). Image of the scientist among high-school students. *Science, 126,* 384–390.

Milford, T.M. and Tippett, C.D. (2013). Preservice teachers images of scientists: do prior science experiences make a difference? *Journal of Science Teacher Education, 24,* 745-762.

Moskal, B. and Skokan, C. (2011). Supporting the K-12 classroom through university outreach. *Journal of Higher Education and Outreach, 15*(1), 53-75.

Newton, L.D. and Newton, D.P. (1998). Primary children's conceptions of science and scientist: is the National Curriculum breaking down the stereotype? *International Journal of Science Education, 20*(9), 1137-1149.

Painter, J., Tretter, T.R., Jones, M.G. and Kubasko, D. (2006). Pulling Back the Curtain: Uncovering and Changing Students' Perceptions of Scientists. *School Science & Mathematics, 106*(4), 181-191.

Platow, M.J. (2012). PhD experience and subsequent outcomes: a look at self-perceptions of acquired graduate attributes and supervisor support. *Studies in Higher Education, 37*(1), 103-118.

Ruiz-Mallén, I. and Escalas, M.T. (2012). Scientists seen by children: A case study in Catalonia, Spain. *Science Communication, 34*(4), 520-545.

Schibeci, R.A. (1986). Images of science and scientists and science education. *Science Education, 70*(2), 139-149.

Sinclair, M. (2004). *The pedagogy of 'good' PhD supervision: A national cross-disciplinary investigation of PhD supervision.* Canberra: Australian Government, Department of Education, Science and Training. Retrieved from http://w3.unisa.edu.au/researcheducation/supervisors/docum ents/phd_supervision.pdf.

Sjøberg, S. and Schreiner, C. (2010). *The ROSE project: An overview and key findings*. Retrieved from http://roseproject.no/network/countries/norway/eng/nor-Sjoberg-Schreiner-overview-2010.pdf.

Tytler, R., Osborne, J., Williams, G., Tytler, K. and Cripps-Clarke, J. (2008). *Opening up pathways: Engagement in STEM across the primary-secondary school transition*. Retrieved from http://dro.deakin.edu.au/eserv/DU:30002876l/williams-openingup-2008.pdf.